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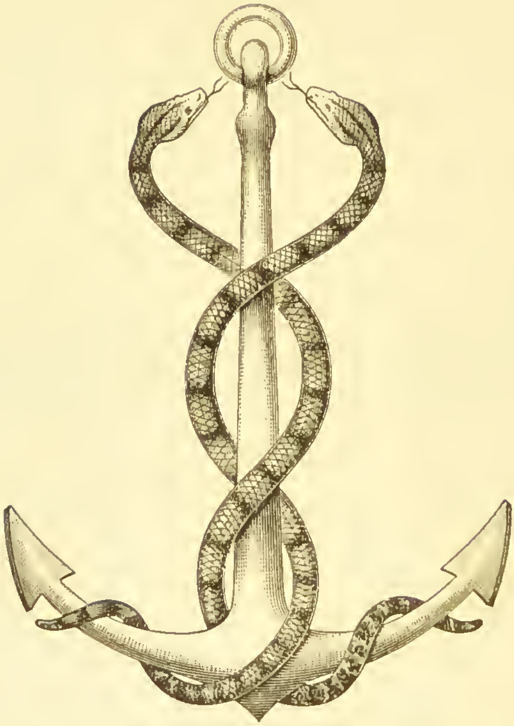
MANUAL OF ANATOMY.



NUNQUAM ALIUD NATURA, ALIUD SAPIENTIA DICIT.

MANUAL

OF

PRACTICAL ANATOMY

BY

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THORAX; HEAD AND NECK.

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PRACTICAL ANATOMY.

THORAX.

THE dissection of the thorax is commenced on the *eleventh* day[1] after the subject has been placed in the dissecting room. By this time the upper limbs have been detached from the trunk.

In form the thorax resembles a truncated cone. In front and behind it is flattened; but laterally it is full and rounded. During life the movements of the thoracic walls produce alterations in the capacity of the chest cavity, and play an essential part in the function of respiration.

In front, the thoracic cavity is bounded by the sternum and costal cartilages; behind, it is bounded by the twelve dorsal vertebræ and the intervening cartilaginous discs, together with the portions of the ribs which extend outwards from the vertebral column as far as the angles; laterally, the shafts of the ribs from their angles behind to their anterior extremities in front limit the thoracic cavity. These parts constitute the framework of the thorax, and can be studied on the skeleton.

[1] Saturdays and Sundays are not counted.

The anterior wall of the thorax is shorter than the posterior wall. Thus, during expiration, the upper margin of the manubrium sterni is placed opposite the disc between the second and third dorsal vertebræ, whilst the lower end of the body of the sternum corresponds in level with the middle point of the body of the ninth dorsal vertebra. The bodies of the dorsal vertebræ project forwards into the cavity of the thorax, and greatly diminish its antero-posterior diameter in the mesial plane; but on either side of the vertebral column, owing to the backward sweep of the posterior portions of the ribs, a deep hollow is formed for the reception of the most massive part of the lung.

The superior aperture, or *inlet of the thorax*, is a narrow opening which is bounded by the first dorsal vertebra, the first pair of costal arches, and the manubrium sterni. The plane of this opening is very oblique; it slopes from behind forwards and downwards. Through the inlet of the thorax enter the windpipe, gullet, the pneumogastric nerves, the gangliated cords of the sympathetic, and the great veins which carry blood towards the heart from the head and neck and the superior extremities; whilst through the same opening egress is given to the thoracic duct and to the arteries which convey blood to the neck, head, and upper limbs.

The base or dependent part of the thorax is very wide, and is sometimes called the *outlet*. In front it is bounded by the ensiform cartilage, and behind by the twelfth dorsal vertebra. Between these points the lower margin of the thorax presents a curved outline. Starting from the sternum, it proceeds downwards, outwards, and backwards along the cartilages of the seventh, eighth, ninth, and tenth ribs. At the tip of the eleventh rib the direction of the lower margin of the thorax changes, and it proceeds upwards, backwards, and inwards along the twelfth rib to the vertebral column.

Attached to the lower margin of the thorax is the *dia-*

phragm, a muscular partition which intervenes between the cavity of the chest above and the cavity of the abdomen below. It is highly vaulted or dome-shaped, and projects upwards so as to form a convex floor for the thorax, and a concave roof for the abdomen. The upward projection of the diaphragm greatly diminishes the vertical depth of the thoracic cavity.

But the diaphragm does not form an unbroken partition. It presents three large openings, by means of which structures pass to and from the thorax, viz.—(1) for the aorta, thoracic duct, and vena azygos major; (2) for the œsophagus and pneumogastric nerves; (3) for the inferior vena cava. Besides these there are other smaller apertures which will be mentioned later on.

THORACIC WALL.

Two days at least should be devoted to the dissection of the thoracic wall.

In addition to the osseous and cartilaginous framework, the walls of the chest are built up partly by muscles, and partly by membranes, and in connection with these there are numerous nerves and blood vessels.

Muscles, . . .	External intercostals. Internal intercostals. Triangularis sterni.
Membranes, . .	Anterior intercostal membrane. Posterior intercostal membrane. Pleural membrane (parietal part).
Nerves and Arteries,	Intercostal nerves. Aortic intercostal arteries. Superior intercostal artery. Internal mammary artery.

Dissection.—Portions of certain of the muscles of the upper limb and of the abdominal wall will be noticed attached to the thoracic wall. From before backwards the dissector will meet with the *pectoralis major*, the *pectoralis minor*, and the *serratus magnus*, whilst towards the lower margin of the chest he will recognise the *rectus abdominis* in front, and

the *obliquus externus* and *latissimus dorsi* upon its lateral aspect. The rounded tendon of the *subclavius* may also be observed taking origin from the first costal arch, and posteriorly to this the *scalenus posticus* extends downwards to its insertion into the second rib. With the single exception of the scalenus posticus, these muscles should be removed so as to lay bare the costal arches and the intercostal muscles. In detaching the serratus magnus be careful not to injure the *lateral cutaneous nerves* which make their appearance in the intervals between its digitations. The *anterior cutaneous nerves* and *perforating branches* of the internal mammary artery must also be preserved ; they pierce the origin of the pectoralis major in the intervals between the costal cartilages, and close to the margin of the sternum.

Intercostal Muscles.—These muscles occupy the eleven intercostal spaces on each side of the thoracic wall. In each space there are two strata of muscular fibres — a superficial and a deep. The superficial layer of muscular fibres is called the *external intercostal muscle*, and the deep layer the *internal intercostal muscle.*

The *external intercostal muscles* (intercostales externi) are already exposed, and very little cleaning is necessary to bring out their connections. Observe that entering into their constitution there is a large admixture of tendinous fibres, and that these, as well as the muscular fibres, are directed from above, obliquely downwards and forwards from the lower border of the rib above to the upper border of the rib below. They do not extend further forwards in the various spaces than a point corresponding to the union of the bony with the cartilaginous parts of the costal arches. In many cases, especially in the upper spaces, they do not reach so far. Here the muscular fibres stop short, but the tendinous fibres are prolonged onwards to the sternum in the form of a membrane, which may be called the *anterior intercostal membrane.* The external intercostal muscles of the two lower spaces are exceptions to this rule. They extend forwards to the extremities of the spaces. Posteriorly the muscles pass backwards as far as the tubercles of the ribs, but this is a point which can only be satisfactorily demonstrated after the thorax has been opened.

Dissection.—To bring the *internal intercostal muscles* into view it is necessary to reflect the external intercostal muscles, and also the anterior intercostal membranes. Divide them along the upper borders of the ribs which bound the spaces inferiorly, and throw them upwards. This dissection should be performed in each intercostal space, and, in effecting it, care must be taken of the intercostal arteries which lie between the two muscular strata.

The *internal intercostal muscles* (intercostales interni) thus laid bare will be seen to be similar in their constitution to the external muscles. The fibres, however, run in the opposite direction—viz., from above, obliquely downwards and backwards. Superiorly, they are attached to the inner surface of the upper rib, immediately above the subcostal groove; inferiorly, they are attached upon the inner surface of the lower rib, close to the upper margin. The internal intercostal muscles are prolonged forwards to the sternum. Posteriorly they reach backwards to the angles of the ribs, from which to the spine the muscles are replaced by a series of thin membranes—the *posterior intercostal membranes*—which will be seen after the thorax has been opened. If the internal oblique muscle of the abdomen has not been removed, the dissector should note that the anterior fibres of the two lowest internal intercostal muscles become continuous with the fibres of that muscle.

Intercostal Nerves.—The intercostal nerves are altogether out of sight in the present stage of the dissection. They are hidden by the lower borders of the ribs which bound the intercostal spaces superiorly. By gently pulling upon their lateral cutaneous branches they can be drawn downwards, and they are then seen to lie between the two muscular strata as far forward as a point midway between the spine and sternum. Here they disappear from view by sinking into the substance of the internal intercostal muscles, amidst the fibres of which they may be traced as far as the anterior extremities of the bony ribs. They now reach the deep surface of these muscles and are carried inwards, first upon the pleura, and then upon the triangu-

laris sterni muscle. Lastly, they cross the internal mammary artery, and come forwards at the side of the sternum as the *anterior cutaneous nerves* of the pectoral region. Each nerve, before it reaches the surface, pierces —(*a*) the internal intercostal muscle; (*b*) the anterior intercostal membrane; (*c*) the origin of the pectoralis major; and (*d*) the deep fascia (Fig. 154).

But this description only holds good for the upper five

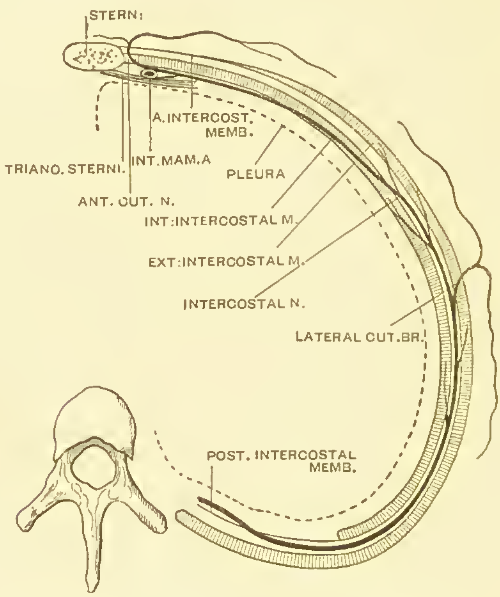

FIG. 154.—Diagram of one of the upper intercostal nerves.

intercostal nerves. The *lower six nerves*, on leaving the anterior ends of the intercostal spaces, pass forwards into the abdominal wall between the internal oblique and transversalis muscles, where they have already been displayed by the dissector of the abdomen.

The intercostal nerves, as they traverse the thoracic wall, give off—(*a*) the lateral cutaneous branches; and (*b*) twigs to the intercostal muscles and triangularis sterni. Their

terminal branches constitute the anterior cutaneous nerves. The lateral cutaneous branches come off midway between the spine and the sternum, and, piercing the external intercostal muscles, appear in the intervals between the digitations of the serratus magnus.

It is not necessary to make a dissection of the intercostal nerves in more than two or three of the spaces.

Intercostal Vessels.—The intercostal arteries should be dissected in those spaces in which the nerves have not been traced, and in which, therefore, the internal intercostal muscles are still entire. It is only in a well-injected subject that a satisfactory view of these vessels can be obtained. In each intercostal space *one* artery is found passing from *behind forwards* and *two*, the *anterior intercostal arteries*, running from *before backwards*.

In the upper two spaces the vessels which run from behind forwards are derived from the *superior intercostal branch* (truncus costo-cervicalis) of the subclavian artery; in the nine lower spaces they spring directly from the aorta, and are called the *aortic intercostal arteries*.

The *anterior intercostal arteries* of the upper six spaces proceed directly from the internal mammary, whilst in the case of the lower spaces they come from the outer of its two terminal branches—viz., the musculo-phrenic artery (Pl. II.).

The intercostal vessels are for the most part distributed between the two muscular strata. From the angles of the ribs onwards to a point midway between the spine and sternum, the *aortic intercostal arteries* lie under shelter of the lower margins of the ribs which bound the spaces superiorly, and at a higher level than the corresponding nerves. Here each divides into two branches, and these pass forwards in relation to the upper and lower margins of the intercostal space. They give off small branches which accompany the lateral cutaneous nerves. The *superior intercostal arteries* are disposed in a similar manner. The

anterior intercostal arteries are two in number for each space. At their origin they lie under cover of the internal intercostal muscles, and they run outwards in relation to the upper and lower margins of the ribs bounding each space. After a short course they pierce the internal intercostal muscles, and end by anastomosing with the aortic and superior intercostal arteries.

Dissection.—The dissector should next proceed to remove the intercostal muscles. This dissection must be carried out with more than usual care, because immediately subjacent to the internal intercostal muscles, over the greater extent of the chest wall, is the delicate pleural membrane lining the inner surface of the costal arches. *Upon no account detach this membrane from the deep surface of the ribs*, and take the greatest care to preserve it intact during the dissection.

On the front of the chest, the *internal mammary artery* and the *triangularis sterni muscle* will be seen to intervene between the pleura and the costal cartilages. The internal mammary artery, with its two companion veins, will be seen descending in a vertical direction, about half-an-inch from the outer margin of the sternum. Clean these vessels carefully in the intervals between the costal cartilages, and note some small lymphatic glands which lie along the course of the vessels. As a rule, the artery ends by dividing into two terminal branches in the interval between the sixth and seventh rib cartilages. Most likely this space will be so narrow that a view of the bifurcation cannot be obtained. If this be the case pare away the edges of the cartilages over the artery, or if necessary remove the inner part of the sixth cartilage completely. The perforating branches of the internal mammary artery which accompany the anterior cutaneous nerves should be preserved.

The muscle upon which the internal mammary artery lies is the triangularis sterni. Endeavour to define its slips in the intervals between the costal cartilages.

Towards the lower margin of the thorax the pleural sac is not prolonged downwards to the lowest limit of the recess between the diaphragm and the costal arches. Indeed, in the axillary line, it will be found to fall considerably short of this. Consequently, when the internal intercostal muscles are removed from this portion of the chest wall, the dissector will come down directly upon the diaphragm ; and, as the fibres of the diaphragm correspond somewhat in their direction with those of the internal intercostal muscles, it is no uncommon occurrence for the student to remove them, and thus expose the peritoneum, under the impression that he has simply laid bare the pleura. When the dissection

has been properly executed, a strong fascia will be observed to pass from the surface of the diaphragm on to the surface of the costal pleura so as to hold it in position. Preserve this for further examination.

The Internal Mammary Artery (arteria mammaria interna) arises in the root of the neck from the first part of the subclavian, and enters the thorax, by passing downwards behind the inner end of the clavicle and the cartilage of the first rib. Accompanied by two veins, it descends to the interval between the sixth and seventh costal cartilages, where it ends by dividing into the *superior epigastric* and the *musculo-phrenic branches.* It runs parallel with the outer margin of the sternum, from which it is separated by an interval of about half-an-inch.

Placed *in front* of the internal mammary artery are the upper six costal cartilages, with the intervening intercostal muscles and anterior intercostal membranes. It is crossed by the series of intercostal nerves before they turn forwards to gain the surface. In the upper part of its course the artery is supported by the pleura, but lower down it rests upon the triangularis sterni which intervenes between it and the pleural sac.

In addition to its two terminal branches, a large number of small collateral twigs proceed from the internal mammary—

1. The anterior intercostal, . 2. The perforating, . .	to the thoracic parietes.
3. The comes nervi phrenici, 4. Mediastinal and thymic,	to parts in the interior of the thorax.
5. Superior epigastric, . . 6. Musculo-phrenic, . .	the terminal branches.

The *anterior intercostal arteries* (rami intercostales) are supplied to the upper six intercostal intervals, and have already been dissected (p. 7). Two are given to each space: frequently these arise by a common trunk.

The *perforating arteries* (rami perforantes) accompany the anterior cutaneous nerves, and reach the surface by piercing the internal intercostal muscles, the anterior intercostal mem-

branes, and the pectoralis major muscle. One, or perhaps two, are given off in each intercostal space. And in the female two or three of the intermediate members of the

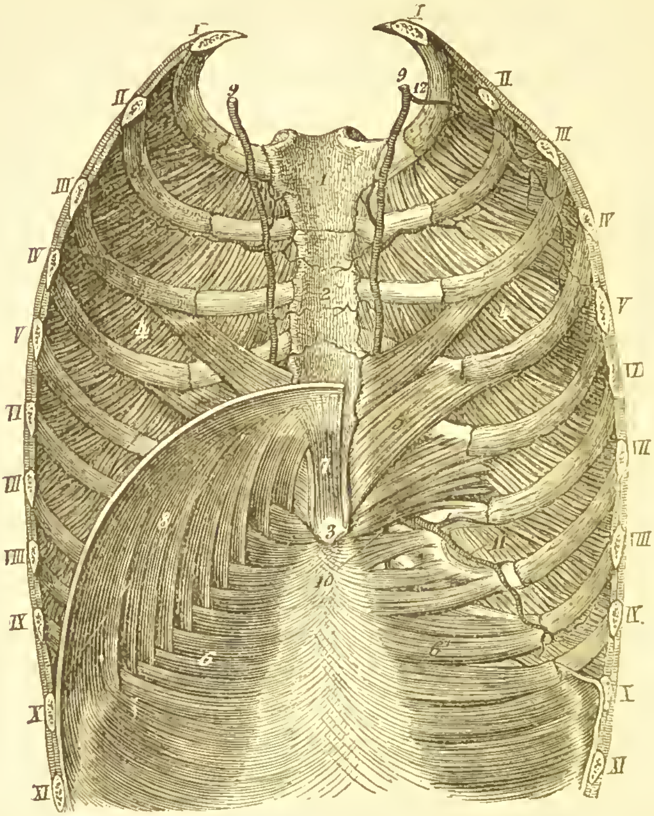

FIG. 155.—Posterior aspect of the anterior wall of the thorax and upper part of the abdomen. (From LUSCHKA.)

1. Manubrium sterni.
2. Gladiolus.
3. Ensiform cartilage.
4. Internal intercostal muscle.
5. Triangularis sterni.
6. Transversalis abdominis.
7. Sternal origin of diapbragm.
8. Costal origin of diaphragm.
9. Internal mammary artery.
10. Superior epigastric artery.
11. Musculo-phrenic artery.
12. An occasional branch of the internal mammary.

series (rami mammarii) attain a special importance, inasmuch as they constitute the principal arteries of supply to the mammary gland.

The *superior epigastric artery* (arteria epigastrica superior) enters the sheath of the rectus muscle of the abdominal wall by passing downwards behind the seventh costal cartilage.

The *musculo-phrenic artery* (arteria musculo-phrenica) turns outwards and downwards along the costal origin of the diaphragm and behind the rib-cartilages. Opposite the eighth costal cartilage it pierces the diaphragm and enters the abdomen. It gives off the *anterior intercostal arteries* to the lower intercostal spaces (p. 7).

The Triangularis Sterni (transversus thoracis) is a thin muscular layer placed on the deep surface of the sternum and costal cartilages. It is continuous below with the transversalis muscle of the abdominal wall, and arises from the posterior surface of the ensiform cartilage, the lower part of the body of the sternum, and from the inner ends of the 5th, 6th, and 7th costal cartilages. From this origin its fibres radiate in an upward and outward direction, and separate into five slips, which are inserted into the deep surfaces and lower borders of the 2nd, 3rd, 4th, 5th, and 6th costal cartilages, close to their junction with the ribs (Fig. 155, and Pl. II.).

In many cases the muscle is feebly developed, and does not show connections so wide as those which are described above. Upon the superficial aspect of the triangularis sterni are placed the internal mammary artery and the series of intercostal nerves.

It is only a partial view of the muscle which is obtained in the present dissection, but it is not advisable to remove the costal cartilages to expose it further, as this would very materially interfere with the subsequent display, in their proper relations, of other more important structures.

THORACIC CAVITY.

The arrangement of the two pleural sacs within the thoracic cavity must now engage the attention of the student; but in order that the relations of these may be understood, it is absolutely necessary that the dissector should have some preliminary knowledge of the thoracic

viscera. The principal viscera of the chest are the lungs and the heart. The two *lungs* occupy by far the greatest part of the space, and lie one upon either side of the mesial plane. The *heart* is placed between the lungs, and projects

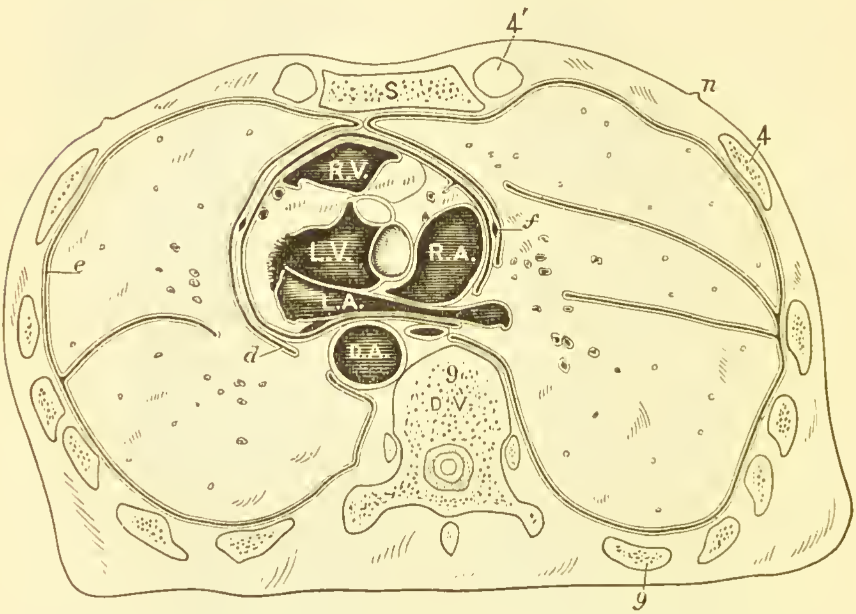

FIG. 156.—Horizontal section of the thorax of a man aged 57, looked at from above. (From SYMINGTON.)

9 D.V. Ninth dorsal vertebra, cut near its upper surface.
S. Body of sternum.
4, 9. Fourth and ninth ribs; between these are the fifth, sixth, seventh, and eighth ribs.
4′. Fourth costal cartilage.
N. Nipple.
R.V. Conus arteriosus of right ventricle.
R.A. Right auricle.
L.A. Left auricle. } Between these
L.V. Left ventricle. } the mitral valve.
Between L.V. and R.A. are portions of two of the aortic semilunar valves.
D.A. Descending aorta; to its right side, the œsophagus.
f. Right phrenic nerve.
e. Left pleural cavity.

more into the left than the right side of the cavity. It is completely enveloped by a loose conical fibro-serous sac called the *pericardium*, which is attached by its base to the upper surface of the diaphragm. Each lung is connected

with the base of the heart by several large vessels which pierce the pericardium, and these, with the corresponding division of the windpipe passing to the lung, constitute the *pulmonary root* or *pedicle.* The lungs are free within the thorax except where they are attached by their roots.

Pleural Sacs.—The pleural sacs are two in number, one in each side of the chest cavity. They are serous sacs, and therefore closed. Each pleural bag is so disposed that it not only lines the recess in which the lung lies, but is also reflected over the lung so as to give to it an external covering, which is intimately connected with the pulmonary substance. We recognise, therefore, in connection with each pleura a *lining* or *parietal part*, and an *investing* or *visceral part.* It must be clearly understood, however, that these terms are merely applied to indicate different portions of one continuous membrane.

The dissection which has already been made shows the pleura lining the deep surface of the costal arches and internal intercostal muscles. This portion is called the *pleura costalis.* The manner in which the pleura of each side is reflected backwards from the posterior aspect of the sternum must now be investigated. This entails a somewhat complicated dissection.

Dissection.—The sternum must be divided with the saw into four portions by three separate cuts, viz. (1) a transverse section through the manubrium sterni, on a line with the *lower* margins of the first pair of costal cartilages; (2) a transverse cut through the lower part of the body of the sternum, in the interval between the *fifth* and *sixth* costal cartilages; (3) an oblique section, beginning below at the inferior transverse cut, close to the left margin of the sternum, and carried upwards to the middle of the superior transverse cut. By the last section the central portion of the sternum is divided into two lateral pieces, to each of which four costal arches are attached (Fig. 157).[1]

In making these sections through the sternum, the saw should only be used until the thick periosteum on the back of the bone is reached. This can then be divided cautiously with the knife. Of course the

[1] This dissection was devised by Sir William Turner.

internal mammary vessels must be preserved, and the greatest care must be taken not to separate the parietal pleura at any point from the deep surface of the thoracic wall.

Anterior Mediastinum.—The two lateral portions of the central piece of the sternum should now be gently separated from each other, and, on looking between them, the parietal pleura of each side will be seen leaving the posterior surface

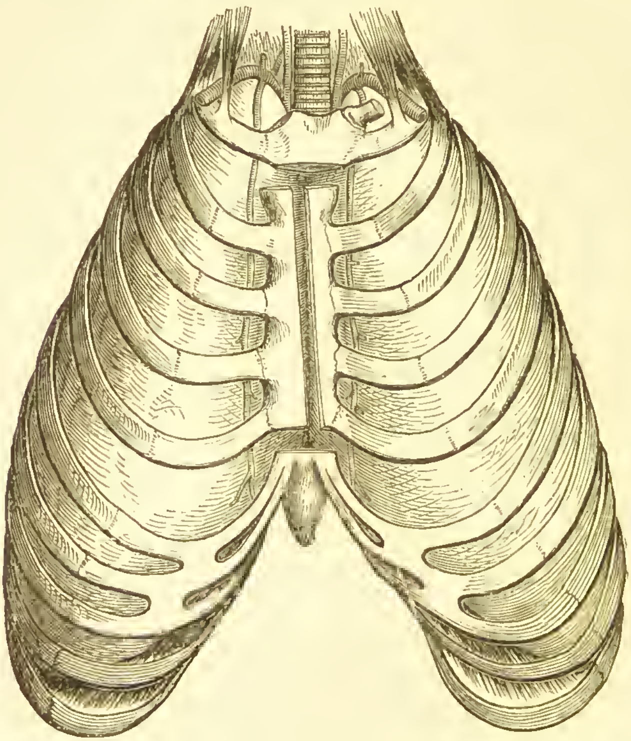

FIG. 157.—Dissection to expose the anterior mediastinum.

of the sternum, and passing backwards to reach the pericardium. But the pericardium is not in view, except perhaps to a very small extent below, because the two pleural membranes, where they make this reflection, are in contact. Introduce the finger between the two pleural sacs, and pass it upwards and downwards through the loose

areolar tissue which holds them together. The pericardium is in this way exposed, and a striking demonstration is obtained of a space which is termed the *anterior mediastinum*. *In front* this space is bounded by the posterior surface of the body of the sternum, and usually also by the inner ends of the fifth, sixth, and seventh costal cartilages of the left side, clothed by the left triangularis sterni muscle; *behind*, by the pericardium; and *upon each side*, by the pleura as it passes from the back of the sternum to the front of the pericardium. In its upper part the space can hardly be said to exist, seeing that the pleural sacs are in contact; but below, the left pleura falls somewhat short of the right pleura, and an interval is apparent. The only contents to be noticed in the anterior mediastinum are, in its lower part, a few small lymphatic glands and some loose areolar tissue, in which ramify lymphatic vessels and some minute arterial twigs from the internal mammary artery.

Dissection.—Having now ascertained the relations of the pleura to the chest wall, proceed to the study of its connections within the thorax. For this purpose the parietal pleura must be separated from the ribs as far forwards as the cartilages. This can best be done by gently insinuating the forefinger between each of the ribs and the pleura, and then running it backwards and forwards. Upon no account detach the pleura from the cartilages. Next divide with the knife the *second*, *third*, *fourth*, *fifth*, and *sixth* costal arches at the junction of the osseous with the cartilaginous portions, and remove these ribs by snipping through them with the bone pliers as far back as possible. The sternum and cartilages, to which the pleura is still adherent, must be left in position until the arrangement of the membrane has been thoroughly investigated.

The greater part of the costal pleura now lies flaccid upon the surface of the lung. Make a vertical incision through it, midway between the spine and sternum, from the level of the second costal arch down as far as the seventh rib. From each extremity of this vertical cut carry an incision forwards for two or three inches.

Relations of Pleura.—A considerable piece of the parietal pleura can now be thrown forwards like a door, and the interior of the pleural sac is exposed. The inner

surface of the membrane, if healthy, presents an appearance which is characteristic of all serous membranes. It is smooth, polished, and glistening, and is moistened by a small amount of serous fluid. It is thus admirably adapted to allow the movements of the lung during respiration to take place with the smallest possible degree of friction. When the surface of the membrane becomes roughened by inflammatory exudation, the so-called "friction sounds" of pleurisy become evident when the ear is applied to the chest.

Introduce the hand into the pleural sac, and explore its

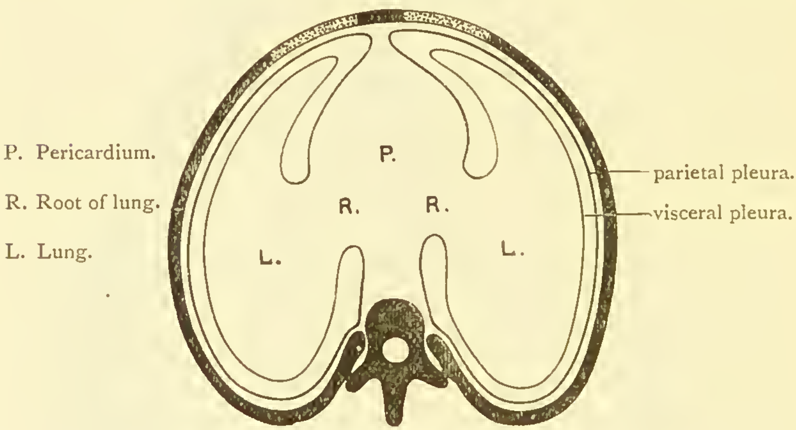

FIG. 158.—Diagram of the two pleural sacs.

extent and connections. First carry it inwards behind the costal cartilages. Its passage across the mesial plane of the body is effectually barred by the reflection of the pleural membrane from the back of the sternum to the front of the pericardium. Above the level of the pericardium it passes right back to the vertebral column, and then proceeds outwards on the ribs. Upon the lateral aspect of the pericardium it can be traced backwards towards the spine, and here it must be studied from two points of view, viz. (1) at the level of the root of the lung, and (2) below the root of the lung.

At the level of the pulmonary root, the pleura is carried outwards, so as not only to envelope this, but also the entire lung. The smooth glistening surface of the organ is due to the pleural investment which it thus acquires. This, then, is the *visceral pleura*, and it should be noticed that it is very much finer and thinner than the parietal pleura. Further, it is inseparably attached to the pulmonary substance. Behind the root of the lung the pleura is prolonged backwards upon the pericardium, and on the left side over the descending thoracic aorta to the bodies of the vertebræ. On the right side it passes directly from the pericardium to the bodies of the vertebræ. This can be seen by tilting forwards the thick posterior border of the lung. From the vertebræ, the pleura passes outwards upon the deep surfaces of the ribs.

Below the level of the root of the lung, the pleura can be traced backwards upon the pericardium to the spine, from which it is conducted outwards upon the ribs. But it does not pass backwards uninterruptedly.

The same two layers which envelop the pulmonary root are prolonged outwards from the pericardium in apposition with each other. Meeting the inner surface of the lung, they separate to enclose the lower portion of this organ. The fold of pleura which is thus formed is called the *ligamentum latum pulmonis*, and it can be brought into view by enlarging the opening in the pleural sac, and drawing the basal portion of the lung outwards and backwards. It will then be seen in the form of a triangular fold of pleural membrane, which extends from the lower border of the pulmonary root along the inner surface of the lung to the diaphragm.

The dissector has now traced the continuity of the pleural sac in the transverse direction. He has observed that it lines the deep surface of the costal arches, and is reflected backwards in the form of an intra-thoracic partition from the back of the sternum to the spine. This partition is called the *mediastinal pleura*, and it is uninterrupted, except where

it is pushed outwards over the lung and lung-root in the form of an investment. But the continuity of the membrane in a longitudinal direction must also be established. This inquiry will render clear its relations in the upper and lower parts of the thoracic cavity.

In the upper part of the chest cavity, the pleura will be observed to extend upwards through the thoracic inlet into the root of the neck, and to form in this locality a dome-shaped roof for each side of the chest (Fig. 157). This portion of the pleura is called the *cervical pleura*, and it passes upwards above the level of the anterior part of the first costal arch for a distance of from 1 to 2 inches. The height to which it rises varies considerably in different individuals. The subclavian artery arches over and lies in a groove on the inner and anterior aspect of this *cul-de-sac* near its summit, and the scalenus anticus muscle is in relation to its outer surface. Further, the cervical pleura is supported and strengthened by an aponeurotic expansion (*Sibson's fascia*) which is spread over it, and receives attachment to the inner concave margin of the first rib. This fascia is derived from a small muscular slip which takes origin from the transverse process of the seventh cervical vertebra. It may be regarded as a derivative from the scalene group of muscles.

In the lower part of the thorax the parietal pleura is reflected from the inner surface of the chest wall on to the upper surface of the diaphragm, and is carried inwards upon this towards the pericardium. This portion of the membrane is termed the *diaphragmatic pleura*.

The Lines of Pleural Reflection.—The two pleural sacs are not shaped alike. The right pleura is shorter and wider than the left, and consequently the lines along which the two membranes are reflected from the sternum and costal cartilages backwards towards the pericardium, and also from the chest wall on to the diaphragm, differ somewhat on the two sides.

Behind the manubrium sterni the two pleural sacs are separated from each other by an angular interval, but near the upper end of the gladiolus they come together, and proceed downwards in close contact, and slightly to the left of the mesial plane, as far as the sternal end of the fourth costal cartilage. Not only are they in contact, but in transverse sections through the chest, it will be seen that the left pleural sac in this position slightly overlaps the right pleural sac (Fig. 159). At the level of the attachment of the fourth costal cartilage to the sternum the two sacs part company. The left pleura deviates outwards, whilst the

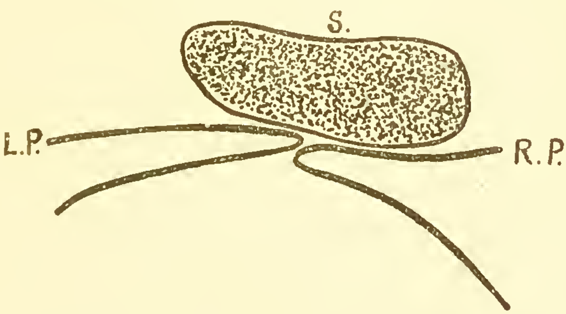

FIG. 159.—Tracing from a transverse section through the frozen chest, at the level of the junction of the third costal cartilages with the sternum.

S. Sternum; L.P. Left pleura; R.P. Right pleura.

right pleura is continued downwards in a straight line behind the sternum to the back of the ensiform cartilage. Here it turns sharply outwards, and running obliquely downwards and backwards upon the deep surface of the seventh costal cartilage, is reflected from this on to the upper surface of the diaphragm. Following the line of diaphragmatic reflection on the right side, it will be seen to continue in a downward and backward direction across the bony extremity of the eighth rib, across the ninth rib, until it reaches *in the axillary line* the ninth intercostal space, or, perhaps, the upper margin of the tenth rib. Crossing the tenth rib, it

runs inwards and backwards along the eleventh rib, and reaches the spine at the level of the neck of the twelfth rib.

Trace now the line along which the left pleura is reflected from the chest wall below the level of the sternal end of the fourth costal cartilage. At this point it retires in an outward direction from the right pleura, and descends at a variable distance from it, so as to leave a small triangular

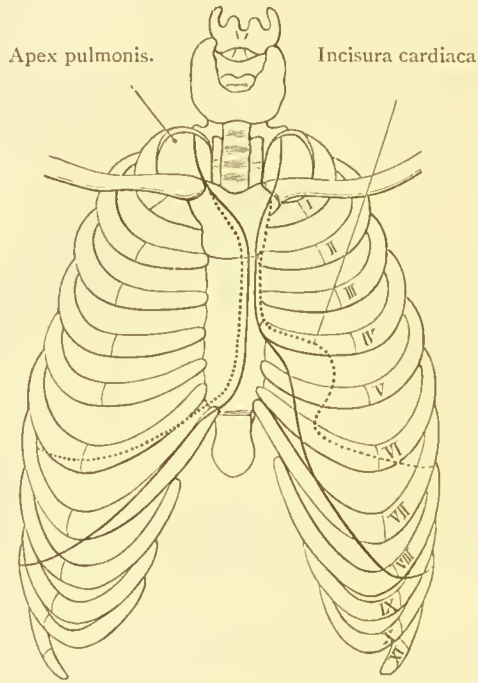

FIG. 160.—The pleural reflection on each side is represented by a solid black line. The outline of the lung is indicated by a dotted line. (From GEGENBAUR.)

portion of the pericardium uncovered by pleura, and in direct contact with the anterior chest wall. This arca is very variable in its extent, but the accompanying diagram (Fig. 160) may be considered to represent the maximum amount of outward deviation of the left pleural sac in connection with this part of the chest wall. As a rule, the area of the pericardium which is left bare is not so extensive.

Proceeding downwards behind the fourth intercostal space, the fifth costal cartilage, the fifth intercostal space, and the sixth costal cartilage, close to the margin of the sternum, the line of left pleural reflection will then be seen to incline obliquely outwards and downwards behind the seventh costal cartilage, and across the eighth, ninth, and tenth ribs, until it reaches a point midway between the spine and the sternum. The line of the diaphragmatic reflection of the left pleura is placed at a slightly lower level than the corresponding line on the right side. The left pleura is therefore deeper than the right pleura, and, *in the axillary line*, it reaches the lower margin of the tenth rib.[1] From this point, as on the opposite side, the lower limit of the left pleura extends backwards along the eleventh rib to the spine, which it reaches at the level of the vertebral extremity of the twelfth rib.

On neither side does the pleura reach to the lowest limit of the recess between the diaphragm and the chest-wall. This has already been noted in the dissection of the intercostal spaces, and a strong fascia has been observed to pass from the uncovered part of the surface of the diaphragm, and from the costal cartilages to the surface of the costal pleura, so as to hold it firmly in place. It may be compared with *Sibson's fascia*, which covers the cervical pleura, but is more strongly marked and more tendinous in character. It may be termed the *phrenico-pleural fascia*.

Mediastinum.—The *mediastinum* or *mediastinal space* is the name which is given to the interval which is left between the two pleural sacs. It is within this space that by far the greater part of the dissection of the thorax has to be con-

[1] According to Lusehka the right pleura in the axillary line only reaches downwards as far as the lower border of the ninth rib; whilst the left pleura in the same line reaches the lower border of the tenth rib. The deepest part of the pleural sac is not in the axillary line, as stated by some authors, but behind, where it is reflected on to the diaphragm along the eleventh and twelfth ribs.

ducted, and, consequently, it is important that the student should acquire an accurate conception of its extent and connections. We have noted that the mediastinal portion of the pleura extends backwards from the front wall of the thorax on either side of the mesial plane, in the form of an intra-thoracic partition. This forms the lateral boundary of the space, whilst in front, it is bounded by the sternum, and behind, by the vertebral column. But it is customary to subdivide in an arbitrary manner the mediastinal space into four portions, termed respectively superior, anterior, middle, and posterior, according to the relations which they present to the pericardium.

Superior Mediastinum.—This is the part of the general mediastinal space which lies above the level of the pericardium. Its *boundaries* are the following:—*In front*, the manubrium sterni, to the posterior aspect of which are attached the lower ends of the sterno-hyoid and sterno-thyroid muscles; *behind*, the upper four dorsal vertebræ with the longus colli muscles; *below*, an imaginary and oblique plane extending from the lower border of the manubrium sterni backwards and upwards to the lower border of the fourth dorsal vertebra; and *laterally*, the mediastinal pleura as it extends on each side from the back of the sternum to the vertebral column.

Figs. 176 and 178 (pp. 65 and 68) are reproduced from tracings of two sections through the superior mediastinum at different levels. Fig. 178 represents a section through its upper part, and Fig. 176 a section through its lower part at the level of the fourth dorsal vertebra. The boundaries, form, and contents of the space are clearly seen.

Within the superior mediastinum are placed—(1) the aortic arch, and the three great vessels which spring from it; (2) the innominate veins and the superior vena cava in its upper part; (3) the trachea, gullet, and thoracic duct; (4) the vagus, phrenic, left recurrent laryngeal and cardiac nerves; (5) the thymus gland. The relative positions of these can

be studied, in the meantime, in Figs. 176 and 178; afterwards they will be displayed in the course of dissection.

The Middle Mediastinum is the wide middle part of the space which contains the pericardium, and lies below the superior mediastinum. In addition to the pericardium and its contents, the middle mediastinum contains the phrenic nerves and their arteriæ comites (Figs. 156 and 177).

The Anterior Mediastinum is that portion of the interpleural space which lies between the pericardium behind and the body of the sternum in front. It has already been examined (p. 14).

The Posterior Mediastinum is situated between the pericardium and the bodies of the vertebræ. It will be studied later on.

Dissection.—The central portion of the sternum, with the attached costal cartilages, may now be removed and laid aside until a suitable opportunity arises for the study of the chondro-sternal joints. Carefully strip the mediastinal pleura from the side of the pericardium. This will bring into view the *phrenic nerve* and the slender *arteria comes nervi phrenici*, a branch of the internal mammary artery which accompanies it upon the side of the pericardial sac. During this dissection the minute *mediastinal* and *thymic branches* of the internal mammary artery will be brought into view.

The Lungs are two soft, spongy organs placed one on either side of the mediastinal space. When the thorax is opened, they collapse to about one-third of their original bulk, and it is difficult for the student to realise their proper dimensions and shape.

With the consent of the dissector of the head and neck, the nozzle of the bellows may be introduced into the cervical part of the trachea so as to inflate the lungs with air. A truer conception of these organs will thus be obtained, and a demonstration will be afforded of their high elasticity, and of their connection with the windpipe.

When healthy and sound, the lungs lie free within the cavity of the chest, and are only attached by their roots and by their ligamenta lata. It is rare, however, that a healthy lung is seen in the dissecting room. Adhesions between

the visceral and parietal portions of the pleura due to pleurisy are generally present. It is accurately adapted to the space in which it lies, and, in the natural state, it bears on its surface impressions and elevations which are an exact counterpart of the inequalities of the parts with which its surfaces are in contact.

In its natural condition, before the chest is opened, each lung is conical in form, and presents for examination an apex, a base, an outer and an inner surface, and an anterior and a posterior border. The *apex of the lung* is blunt and rounded, and rises above the level of the first costal arch, protruding upwards through the thoracic inlet into the root of the neck. The subclavian artery arches outwards upon the inner and front aspects of the apex of the lung, a short distance below its summit, and a groove corresponding to the vessel may be recognised upon it. The cervical pleura intervenes between them. The *base of the lung* presents a semilunar outline, and is adapted to the upper surface of the diaphragm. Consequently, it is deeply hollowed out; and as the right cupola of the diaphragm ascends higher than the left, the basal concavity of the right lung is deeper than that of the left lung. Laterally, and behind, the base of each lung is limited by a thin sharp margin, which passes downwards in the narrow pleural recess (*sinus phrenico-costalis*) between the diaphragm and chest wall. This margin extends much lower down behind and at the outer side than in front.

But the bases of the lungs establish important relations with the viscera, which occupy the costal zone of the abdominal cavity—the diaphragm alone intervening. Thus the base of the right lung rests upon the right lobe of the liver; whilst the base of the left lung is in relation to the left lobe of the liver, the stomach, the spleen, and in some cases to the splenic flexure of the colon (Fig. 163, p. 33).

The *outer surface of the lung* is very extensive and is full and convex. It is in relation to the parietal pleura, as it

clothes the ribs and intercostal muscles, and it bears the impress of the costal arches. The *inner surface* presents a much smaller area than the outer surface, and is deeply concave in adaptation to the pericardium upon which it fits. As the heart projects more into the left side of the chest, the concavity on the inner side of the left lung is more marked than it is in the right lung. Upon this surface is the *hilum*, or the place of attachment of the root. It is situated somewhat nearer the apex than the base, and also nearer the posterior than the anterior border of the lung. Through the hilum enter the arteries, nerves, and bronchus, whilst through the same slit the veins and lymphatics emerge.

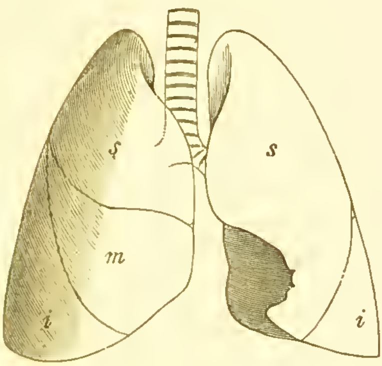

FIG. 161.—The Lungs. (From GEGENBAUR.)

s. Superior lobe; *m*. Middle lobe; *i*. Inferior lobe.

The two borders of the lung stand in marked contrast to each other. The *anterior border* is short, thin, and sharp, and extends forwards and inwards in front of the pericardium into the narrow pleural recess behind the sternum and costal cartilages (*sinus costo-mediastinalis*). The *posterior border of the lung* is thick, long, and rounded. It forms the most bulky part of the organ, and occupies the deep hollow of the thoracic cavity which is placed on each side of the spine.

During respiration the two surfaces, the posterior border and the lower surface of the base and the apex of the lung always remain in close apposition with the walls of the cavity in which the organ lies. The sharp margin around the base rises and falls in the sinus phrenico-costalis, but it is doubtful if it ever, even in the deepest inspiration, reaches the lowest limit of this recess. The anterior sharp margins of the lungs approach and retreat to a slight degree from each other in

front of the pericardium in the sinus costo-mediastinales. In full inspiration, behind the upper two pieces of the gladiolus of the sternum, they are only separated from each other by the two layers of mediastinal pleura, and as a general rule the left lung slightly overlaps in this locality the right lung (Fig. 159).

But there are some points in which the two lungs differ from each other: (1) The right lung is slightly larger than the left, in the proportion of 11 to 10. (2) The right lung is shorter and wider than the left lung. This difference is due to the great bulk of the right lobe of the liver, which elevates the right cupola of the diaphragm to a higher level than the left cupola, and likewise to the heart and pericardium, projecting more to the left than the right, and thus diminishing the width of the left lung. (3) The anterior sharp margin of the right lung is more or less straight; the corresponding margin of the left lung presents, in its lower part, a marked angular deficiency (*incisura cardiaca*) for the reception of the apex of the heart and the pericardium. (4) The right lung is subdivided into three lobes, and the left lung into two.

Lobes of the Lungs.—The *left lung* is divided into two lobes, by a long oblique deep fissure which penetrates its substance to within a short distance of the root. This fissure begins above at the posterior border, about three inches below the apex, and about the level of the vertebral end of the third rib, and is continued in a somewhat spiral direction downwards and forwards to the anterior end of the base of the lung. The upper lobe of the lung lies above and in front of this cleft. It is conical in form with an oblique base. The apex and the whole of the anterior border belong to it. The lower lobe, somewhat quadrangular, lies below and behind the fissure, and belonging to it we recognise the entire base and the greater part of the thick posterior border. It is therefore the more bulky of the two.

In the *right lung* a similar cleft is present, but in addition to this a second fissure maps off from the lower

end of the upper lobe, a third or intermediate lobe. This second cleft begins at the posterior border of the lung in the oblique fissure, and proceeds horizontally forwards on the outer surface to the anterior border. The middle or intermediate lobe of the right lung is triangular or wedge-shaped in outline.

Root of the Lung.—This is the term which is applied to a number of structures which enter the lung at the hilum or slit upon its inner concave surface. These structures are held together by an investment of pleura, and constitute a pedicle which retains the lung in its place when the thoracic cavity is opened.

The pleura should be carefully stripped from around the root of the lung; but, before undertaking the dissection of the structures which compose the root, the relation which it bears to neighbouring parts should be determined.

In front there are—(1) A delicate plexus of nerves, the anterior pulmonary plexus; and (2) the phrenic nerve with the arteria comes nervi phrenici. *Behind*, the pneumogastric nerve breaks up into the posterior pulmonary plexus; whilst, *inferiorly*, there is the ligamentum latum pulmonis. These are the relations which are common to the root of the lung upon both sides of the body, but there are others which are peculiar to each side.

On the *right side*—(1) The vena azygos major, as it passes forwards to join the superior vena cava, is in relation to the upper border of the pulmonary root; (2) the superior vena cava, in the lower part of its course, lies in front of the pulmonary root.

On the *left side*, the aorta arches over the root of the lung, and the descending thoracic aorta passes down behind it.

Dissection.—Now proceed to dissect out the constituent parts of the root of the lung.

Constituent parts of the Pulmonary Root.—The most important structures which enter into the formation of the pulmonary root are—(1) the *two pulmonary veins;* (2) the

pulmonary artery; (3) the *bronchus*. But, in addition to these, there are one or two small *bronchial arteries* and *veins*, the *pulmonary nerves*, and the *pulmonary lymphatic vessels*. These are bound together by some loose areolar tissue, and the whole is invested by pleura.

The *pulmonary nerves* are derived from the anterior and posterior pulmonary plexuses. The *anterior pulmonary plexus* is composed of two or three delicate filaments, which come from the pneumogastric nerve before it reaches the posterior aspect of the pulmonary root. These join with the sympathetic twigs on the wall of the pulmonary artery. The deep cardiac plexus gives twigs to the anterior pulmonary plexus on both sides of the body. But the plexus of the left side is larger than that of the right side, because it likewise receives a few filaments from the superficial cardiac plexus. It is only under the most favourable circumstances that a good dissection of these nerves can be made.

Dissection.—The *posterior pulmonary plexus* is easily dissected. To get at it, the lung must be thrown well forwards over the pericardium, and the pleura stripped from the posterior surface of the pulmonary root. The pneumogastric nerve should then be secured and followed downwards. On the left side it will be found crossing the aortic arch; on the right side it lies by the side of the trachea.

The posterior pulmonary plexus is formed by the entire trunk of the pneumogastric nerve breaking up into a flattened network immediately under cover of the pleura upon the posterior aspect of the root of the lung. Several minute twigs from the upper thoracic ganglia of the sympathetic enter this plexus. The posterior pulmonary plexuses of opposite sides are connected by some strong branches, which cross the mesial plane in front of and behind the œsophagus (Fig. 182, p. 79). From both the anterior and posterior pulmonary plexuses fine twigs are prolonged into the lung along the divisions of the bronchi. The posterior branches, however, are much larger than the anterior.

The *bronchial arteries*, one or two in number on each

side, are the proper nutrient vessels of the lung. They are placed on the posterior aspect of the root of the lung, and have, no doubt, been exposed in the dissection of the

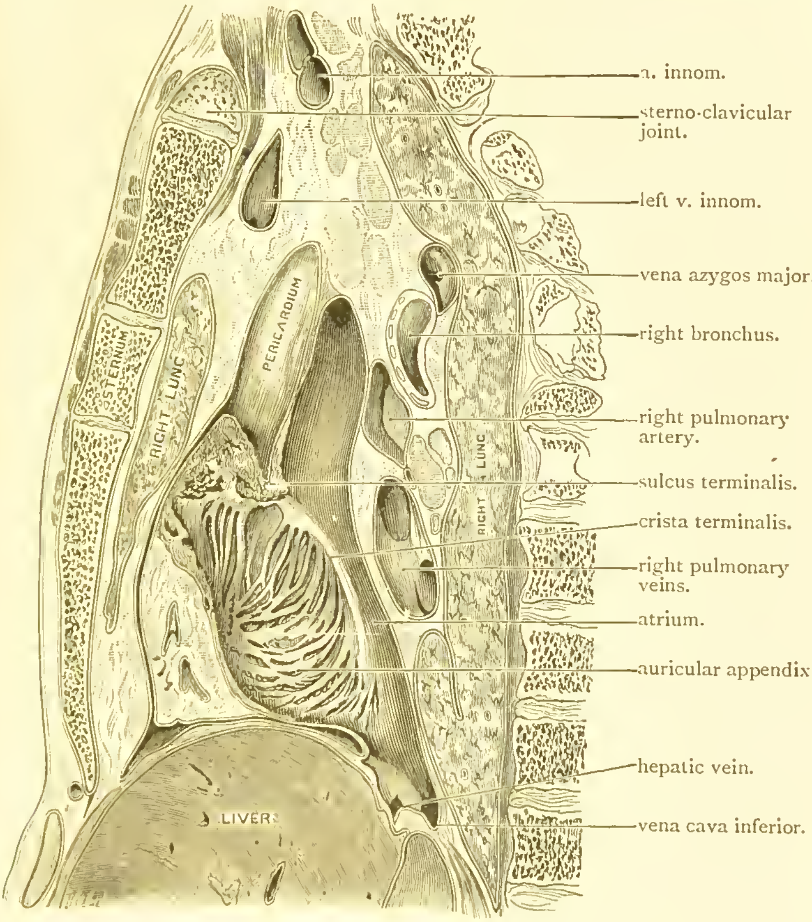

FIG. 162.—Sagittal section through the thoracic cavity a short distance to the right of the mesial plane. The cavity of the right auricle and the relations of the parts forming the right pulmonary root are seen.

posterior pulmonary plexus. As a general rule they lie in close contact with the back of the corresponding bronchus and follow it into the lung.

Dissection.—The *pulmonary vessels* and the *bronchus* should now be separated from each other with the handle of the knife, and their relative positions in the root of the lung studied. This dissection should be made, not only in front, but also behind, so that the parts may be thoroughly isolated and rendered distinct. Hardened and blackened bronchial glands sometimes make the dissection a difficult one. These must be removed.

The *pulmonary veins* are placed *most anteriorly* and the *bronchus most posteriorly*, whilst the *pulmonary artery* is *intermediate* in position. When examined in respect to their relations from above downwards, the right and left pulmonary roots are seen to differ from each other. On both sides the *veins* occupy the lowest level. On the *right side* the bronchus is highest and the artery intermediate, whereas on the *left side* the artery is highest and the bronchus intermediate in position. The different position of the bronchus in the roots of the lungs is not due to any difference in the direction of the main stems or trunks of the tubes, but to the fact that on the right side a branch arises from the bronchus close to its origin, and proceeds almost horizontally outwards to the upper lobe of the lung. This division, which is not represented on the left side, lies above the level of the pulmonary artery, and in consequence receives the name of the *eparterial bronchus*. The other branches of the right bronchus, and all the branches of the left bronchus, lie below the level of the main trunk of the corresponding pulmonary artery, and are termed *hyparterial bronchi*.

The relation of parts in the roots of the two lungs may be shortly expressed thus :—

From Before Backwards.

Both sides, ... { Veins. Artery. Bronchus.

From Above Downwards.

Left side, . .	Artery. Bronchus. Veins.	*Right side*, . .	Bronchus. Artery. Veins.

Phrenic Nerve.—This is a long nerve which arises in the neck from the cervical plexus, and traverses the entire length of the mediastinal space to reach the diaphragm. It has already been exposed upon the lateral aspect of the pericardium in front of the root of the lung. Follow it upwards and downwards.

The phrenic nerve enters the chest cavity through the thoracic inlet, and as it does so it passes behind the subclavian vein, and crosses obliquely the internal mammary artery in a direction from without inwards. It now proceeds downwards through the superior mediastinum into the middle mediastinum. In the latter it is applied to the side of the pericardium in front of the root of the lung, and is covered by the mediastinal pleura. Finally reaching the diaphragm, the nerve breaks up into several branches which pierce its substance and spread out on its under surface.

But the two phrenic nerves of opposite sides present certain differences. They differ (1) in length; and (2) in certain of their relations.

The left phrenic is the longer of the two nerves, and this is due, partly, to the greater projection of the heart and pericardium to the left side, and partly to the fact that the left cupola of the diaphragm which it enters does not rise so high as the right cupola. The differences in relationship are the following:—(1) As they traverse the superior mediastinum the left phrenic nerve crosses the aortic arch, whilst the right phrenic nerve lies in relation to the right side of the right innominate vein and the superior vena cava; (2) one or more of the terminal branches of the right nerve pass through the opening in the diaphragm for the inferior vena cava.[1]

The *branches* of the phrenic are chiefly destined for the

[1] It is sometimes stated that the right phrenic nerve lies deeper in the chest than the left phrenic. This is not the case, as anyone may ascertain for himself by the examination of a series of transverse sections through the frozen thoracic cavity (*vide* Figs. 156, 176, 177, and 178).

supply of the diaphragm, but in its course through the middle mediastinum it gives a few fine filaments to the pericardium and the pleura.

The small branch of the internal mammary artery which accompanies the phrenic nerve, the *arteria comes nervi phrenici*, may be traced in a well-injected subject to the forepart of the diaphragm. It takes origin high up in the thorax, and gives branches to the pericardium.

Superficial Cardiac Plexus.—The best plan to adopt in making a dissection of these delicate nerve filaments is to begin by securing the two cardiac nerves which enter the plexus from above. These are—(1) the cardiac branch from the superior cervical ganglion of the sympathetic of the *left* side; (2) the inferior cardiac branch of the *left* pneumogastric nerve. Look for both of these nerves upon the aortic arch. They will be found crossing it to the left of the phrenic nerve, between it and the pneumogastric nerve. The cardiac branch from the left pneumogastric nerve is the smaller of the two, and as a general rule it lies nearer the phrenic nerve than the other.

The superficial cardiac plexus into which these nerves may be traced lies in the concavity of the aortic arch, and upon the bifurcation of the pulmonary artery. At the point of junction of the nerves the minute *ganglion of Wrisberg* may be discovered. The manner in which this plexus is distributed to the heart will be afterwards noted: in the meantime observe that it gives some fine offsets to the left anterior pulmonary plexus.

Dissection.—The pericardium should now be cleaned. In removing the loose areolar tissue from its anterior surface two ligamentous bands which connect it to the posterior aspect of the sternum will be observed. Of these, one—the *inferior sterno-pericardiac ligament*—binds it to the ensiform cartilage, whilst the other—the *superior sterno-pericardiac ligament*—connects it with the manubrium sterni, and comes into relation with the pretracheal layer of the deep cervical fascia. The upper surface of the diaphragm should be carefully cleaned at the same time, in order that its relation to the pericardium may be studied.

The Pericardium is a fibro-serous sac which loosely envelops the heart. It is placed in the middle subdivision of the mediastinal space, and presents a somewhat conical form. By its *base* it rests chiefly upon the central tendinous part of the diaphragm, but beyond the limits of this it encroaches, to some extent, upon the muscular portion. More especially is this the case on the left side. Except at one point, no difficulty will be experienced in separating the

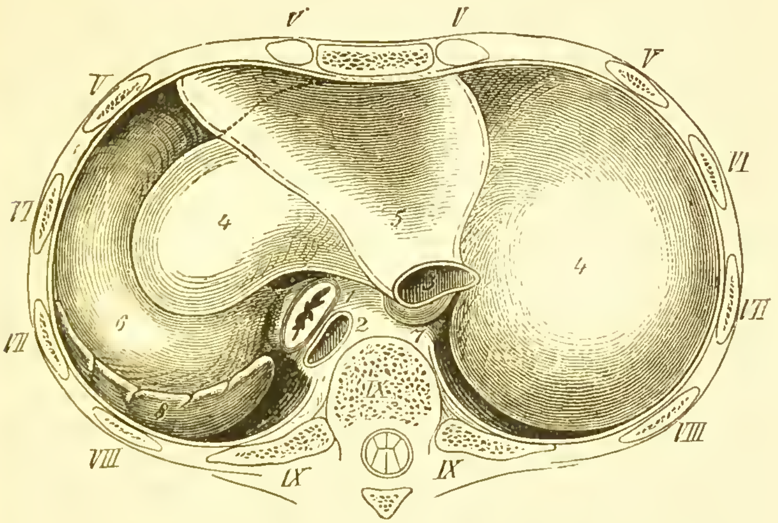

FIG. 163.—Dissection to show the abdominal viscera which lie in relation to the under surface of the diaphragm. The dotted line marks off the part of the pericardium in relation to the stomach. (From BRAUNE.)

1. Œsophagus.
2. Aorta.
3. Vena cava inferior.
4. Liver.
5. Pericardium.
6. Stomach.
7. Lobulus Spigelii of the liver.
8. Spleen.

pericardium from the diaphragm. The two are simply bound together by some intervening areolar tissue. Towards the middle line, however, it will be found over a small area to be inseparably blended with the central tendon. It is important to recognise the abdominal viscera which stand

in relation to the base of the pericardium. It is placed, for the greater part of its extent, over the upper surface of the liver, the diaphragm alone intervening; but in front, a small part corresponding to the apex of the heart projects beyond the area of the liver and comes to lie over the stomach (Fig. 163). The *upper narrow part* of the pericardium will be noticed to close upon certain of the great vessels that issue from the base of the heart. *Upon each side* the pericardium is adapted to the concave inner surface of the lung. It is clothed by the mediastinal pleura, and has in relation to it the phrenic nerve and the arteria comes nervi phrenici. *In front*, very important relations have to be studied. It lies behind the sternum and costal cartilages, and is for the most part separated from these by the two pleural sacs, and by the anterior thin margins of the lungs. Below the level of the sternal end of the fourth costal cartilage, however, owing to the left pleura retreating somewhat to the left, a small area of the anterior surface of the pericardium, as a general rule, comes into direct relation with the chest wall. The extent[1] of this area, as we have already seen, is variable. *Behind*, the pericardium forms the anterior wall of the posterior mediastinum, and is in relation to the contents of this space. Its relation to the œsophagus is especially intimate.

When the pericardium is denuded of the loose areolar tissue which surrounds it and binds it to adjacent structures, the strong dense character of the fibrous membrane which forms its *outer layer* will be seen. This fibrous layer is pierced by the various vessels which pass to and from the heart, and is prolonged upon the walls of these vessels in the form of tubular investments which gradually become lost upon their coats. The only vessel which fails to receive such a prolongation is the inferior vena cava, and this is

[1] The importance of recognising this bare area of the pericardium will be understood when it is remembered that it is here that the surgeon taps the cavity of the sac when distended with fluid.

due to the fact that this vein pierces the pericardium where it rests on the diaphragm, and can, therefore, hardly be said to have any intra-thoracic course outside the pericardium.

The entire length of the pulmonary artery and of the ascending aorta are enclosed within the fibrous sac of the pericardium.

Dissection.—The pericardium may be opened by means of a crucial incision, viz.—(1) a longitudinal incision along the middle line of the body from the point where it blends with the sheath of the aorta downwards to the diaphragm ; (2) a transverse cut, extending from the middle of the root of one lung to a similar point on the opposite side.

The Internal Serous Layer of the Pericardium is now exposed. This layer, which forms a completely closed sac, lines the entire inner surface of the fibrous pericardium, and is reflected from this, upon the vessels which pierce the fibrous layer, on to the surface of the heart. It gives a smooth, polished appearance to the heart and to the interior of the pericardial sac. The lining part of the serous layer is termed the *parietal portion ;* the investing portion which covers the heart is called the *visceral part* or *the epicardium.* The great vessels in connection with the heart, as they lie within the fibrous pericardium, also receive more or less complete coverings from the serous layer. The two arteries —viz., the pulmonary artery and the aorta, are completely surrounded by a single tubular sheath. This investment only leaves uncovered the surfaces of these vessels which are in apposition with each other—a fact which can readily be demonstrated by passing the forefinger behind them. The term *sinus transversus pericardii* is given to the passage through which the finger has been thrust. It intervenes between the two arteries in front, and the auricular part of the heart behind.

In the case of the veins, the covering which they receive from the serous pericardium is not so complete. They are covered in front and on each side, whilst posteriorly they are bare and in contact with the fibrous layer of the

sac. The superior vena cava, which lies immediately to the right of the ascending part of the aorta, is a good example of this. Its lower half is enclosed within the fibrous sac, but only two-thirds of its circumference has a serous covering. The inferior vena cava, which pierces the base of the pericardium, and at once opens into the right auricle of the heart, receives a very small investment.

When the apex of the heart is drawn forwards and upwards, a deep, blind recess of the serous pericardium will be seen, passing upwards behind it, between the pulmonary veins of opposite sides.

Lastly, separate the left pulmonary artery from the upper of the two left pulmonary veins, as they lie within the fibrous pericardium. Stretching across the interval between them will be seen a prominent semilunar fold of the serous pericardium. This is the "*vestigial fold of Marshall.*" It contains between its two layers a minute fibrous band (ligamentum cavæ sinistræ), the remnant of the left superior vena cava of the embryo.

Remains of the Thymus.—The *thymus gland*, which is a very conspicuous object in the superior mediastinum of the fœtus and young child, is only represented in the adult by some condensed tissue of a brownish colour, placed above the level of the aortic arch, and in front of the innominate and left common carotid arteries as they spring from the arch. A few *thymic branches* from the internal mammary artery enter the wasted remains of the gland, and some small veins pass from it and join the subjacent left innominate venous trunk.

Dissection.—Remove the thymus, and dissect out the two innominate veins and the superior vena cava. The left innominate vein will be seen crossing the superior mediastinum from left to right. The short right innominate vein is placed in the upper and right part of the superior mediastinum. The union of these two trunks forms the vena cava superior. The tributaries which enter these veins must also be secured. One, the left superior intercostal vein, ascends upon the aortic arch to reach the left innominate.

Innominate Veins.—The *innominate vein* of each side is formed behind the sternal end of the clavicle by the union of the subclavian and internal jugular veins. Behind the lower part of the junction of the first costal cartilage of the right side with the sternum, they unite to form the superior vena cava.

The *right innominate vein* (vena anonyma dextra) is short. It is not more than one inch in length, and it has a nearly vertical course from above downwards. Its outer surface is covered with pleura and is in relation to the phrenic nerve. The upper part of the innominate artery lies to its inner side.

The *left innominate vein* (vena anonyma sinistra) is much longer than the right vein, and has an oblique course from the left downwards and to the right. It is placed behind the manubrium sterni and the remains of the thymus gland, and crosses the three great arteries which spring from the aortic arch.

The innominate vein of each side receives the following tributaries :—

1. The vertebral vein.
2. The inferior thyroid vein.
3. The vein which drains the blood from the first or highest intercostal space.
4. The internal mammary vein.

The left innominate vein in addition receives the left superior intercostal vein, and some small venous twigs from the thymus gland. The *left superior intercostal vein* is formed by the union of the veins from the second and third intercostal spaces. It crosses the arch of the aorta, and is of interest in so far that its upper part represents the upper pervious portion of the occluded left superior vena cava of the embryo.

The Vena Cava Superior should also be examined at this stage. It is formed behind the first costo-sternal junction of the right side by the union of the two innominate veins. From this it proceeds downwards, and it opens into

the upper part of the right auricle of the heart at the level of the upper border of the third costal cartilage of the right side. It is three inches long, and shows very different relations in its upper and lower parts. In the *upper half* of its course it lies in the superior mediastinum (Fig. 176, p. 65). On the right side it is clothed by the mediastinal pleura, and has the phrenic nerve in contact with it; on the left side it is in relation to the innominate artery. In the *lower half* of its course it is enclosed within the fibrous pericardium, and is placed in the middle mediastinum. The serous pericardium covers it in front and laterally, whilst immediately to its left side is the ascending aorta. This portion of the superior vena cava lies in front of the pulmonary artery and the upper pulmonary vein of the right side (Fig. 177, p. 67).

The *vena azygos major* is the only large tributary which joins the superior vena cava. It comes forwards above the right bronchus, and enters the vena cava immediately above the point where it pierces the pericardium. Minute *pericardiac* and *mediastinal veins* also pour their blood into it.

The Inferior Vena Cava is a larger vessel than the superior vein of the same name. It enters the thorax by piercing the central tendon of the diaphragm. It can hardly be said to have any course within the thorax, seeing that it immediately passes through the base of the pericardium, and opens into the lower and back part of the right auricle of the heart.

The Heart and its Vessels.—The heart is a hollow organ with muscular walls, somewhat conical in shape, and about the size of the clenched fist. It is placed obliquely within the middle mediastinum, so that its basal portion (basis cordis) is directed upwards, backwards, and to the right, whilst its pointed apex looks downwards, forwards, and to the left. But it is also placed unsymmetrically within the chest cavity. In other words, it projects more to the left than to the right, and in cases where the frozen body is divided accurately in the mesial plane, it is found that about

one-third of the organ is in the right, and about two-thirds in the left half of the thoracic cavity (Fig. 164).

The **general relations** of the organ should now be examined. The *base* is placed in front of the middle portion of the dorsal segment of the vertebral column. Four dorsal vertebræ lie above it, and four below it, whilst the intermediate four (viz., the 5th, 6th, 7th, and 8th) lie behind it. The *apex* approaches the anterior wall of the thorax, and in life will be felt beating in the fifth intercostal space of the left side, one and a-half inches below the nipple, and three and a-half inches from the middle line. The *posterior surface* (*facies diaphragmatica*), which is flattened, and looks more downwards than backwards, rests upon the diaphragm—the floor of the pericardium alone intervening. Immediately below the cardiac area of the diaphragm is the upper surface of the liver, and in front and to the left a small piece of the stomach (Fig. 163, p. 33). The *anterior surface* (*facies sternalis*) of the heart looks upwards as well as forwards, and lies behind the greater part of the gladiolus of the sternum and certain of the costal cartilages. On both sides the third, fourth, and fifth costal cartilages are in front of the heart, but as the chief bulk of the organ is situated to the left of the mesial plane, the left sixth costal cartilage is also in front of it. Three costal cartilages on the right side, therefore, and four on the left side are in relation to the anterior surface of the heart. The pleural sacs and the anterior thin margins of the lungs intervene between the

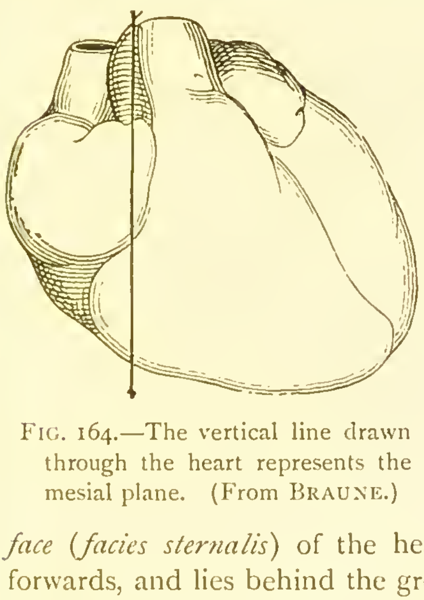

FIG. 164.—The vertical line drawn through the heart represents the mesial plane. (From BRAUNE.)

heart enclosed within the pericardium and the anterior wall of the thorax. A small portion of the pericardium in the lower part of the anterior mediastinum is in direct relation to the triangularis sterni muscle as it covers the deep surface of the sternum, and the inner extremities of the fifth and sixth costal cartilages of the left side. A wider area at the same level, owing to the incisura cardiaca in the anterior margin of the left lung, is uncovered by the lung. This

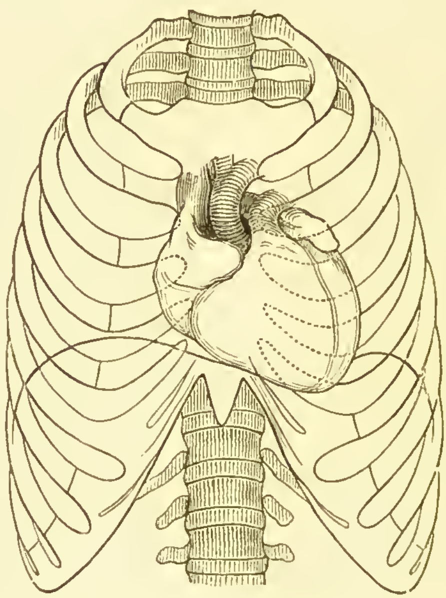

FIG. 165.—Diagram to show the position of the heart in relation to the anterior chest wall. (From BRAUNE.)

area may be mapped out on the chest wall by drawing a vertical line along the middle line of the sternum, from the level of the inner extremities of the fourth costal cartilages to the lower end of the gladiolus, and by carrying two other lines, from the extremities of the first line, outwards so as to meet at a point over the apex beat of the heart. *On either side,* the heart and pericardium is supported by the mediastinal pleura and the inner surface of the lung.

The heart lies free within the sac formed by the pericardium, except where it is attached by the great vessels which are connected with its basal portion. Its position is influenced, to a certain extent, by the position of the body.

External Configuration of the Heart.—In studying the form and appearance of the heart, the dissector will find it advantageous to refer to an injected specimen. At the

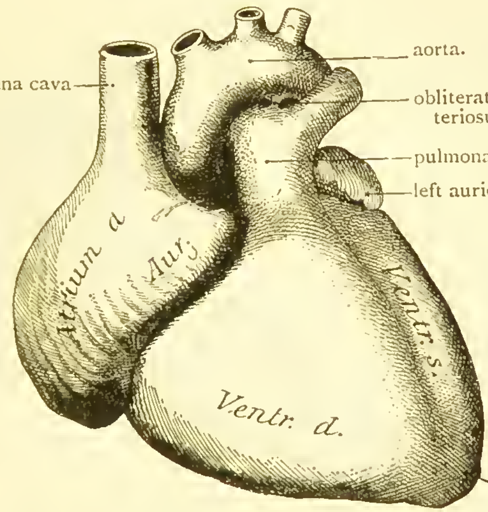

FIG. 166.—Anterior aspect (*facies sternalis*) of the heart. (From GEGENBAUR.)

Ventr. d. Right ventricle. | *Aur.* Right auricular appendix.
Ventr. s. Left ventricle. | *Atrium d.* Right atrium.

same time he should remember that such a specimen is apt to convey an erroneous impression, in so far that during life the auricular and the ventricular chambers are never fully distended at the same time.

The interior of the heart is divided by an internal partition into a right and a left cavity. Further, each of these is still further subdivided into an upper *auricular* and a lower *ventricular chamber*, which communicate freely with

each other through a wide auriculo-ventricular opening. The right and the left cavities of the heart, however, are completely shut off from each other.

On the exterior of the heart there are markings which indicate this internal subdivision, and enable us to map out with the greatest accuracy the walls of the four chambers. Thus encircling the heart in transverse direction, nearer the base than the apex, is a deep furrow which is

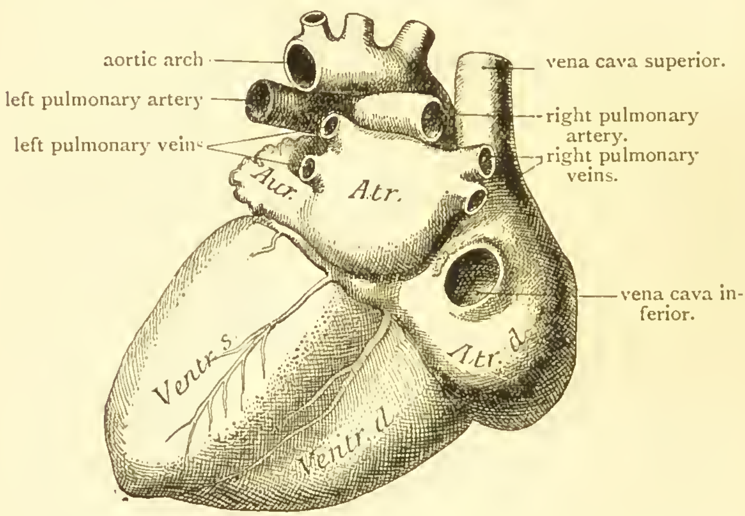

FIG. 167.—Posterior surface *(facies diaphragmatica)* of the heart. (From GEGENBAUR.)

Ventr. s. Left ventricle.
Ventr. d. Right ventricle.
Aur. Left auricular appendix.
Atr. Left atrium.
Atr. d. Right atrium.

continuous all the way round, except in front, where it is interrupted by the root of the pulmonary artery. This is the *auriculo-ventricular groove* (sulcus coronarius). It intervenes between the auricles which lie above it and the ventricles which are placed below it. In the undissected heart, with the epicardium in position, the depth of this furrow is somewhat obscured, from the fact that it lodges some large blood vessels and a certain amount of fat.

The Auricular Part of the heart stands in marked contrast with the firm ventricular portion. Its walls are thin and flaccid, and in the uninjected heart they are collapsed, so that it is difficult to realise the shape of this portion of the organ. It is crescentic in form. The chief bulk of it is placed behind, but it sends forwards two processes or cornua, termed the auricular appendices. A deep concavity or hollow is thus produced, in which lie the two great arterial trunks which spring from the ventricles, viz., the pulmonary artery in front and the aorta behind. The accompanying diagram, which represents a transverse section through the auricular portion of the heart, will serve to illustrate this point (Fig. 168).

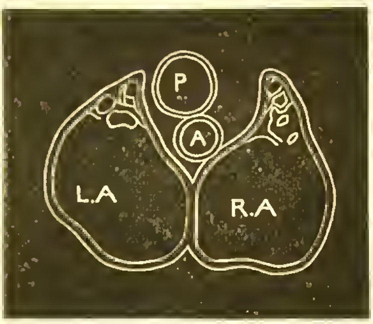

FIG. 168.—Transverse section through the auricular part of the heart.

R.A. Right auricle.
L.A. Left auricle.
P. Pulmonary artery.
A. Aorta.

On the posterior aspect of the auricular part of the heart a faintly marked groove extends upwards in a vertical direction from the auriculo-ventricular furrow (Figs. 167 and 168). This groove passes over the top of the auricular part, and then downwards in front of it. It corresponds to the internal attachment of the inter-auricular septum (septum atriorum), which intervenes between the right and left auricular cavities, and therefore it is termed the *interauricular furrow.* The posterior capacious part of each auricle is somewhat quadrangular in shape, and is called the *atrium:* the prolongation forwards on either side of the great arterial trunks is termed the *auricular appendix* (auricula).

It should be noted that the left auricle forms a greater part of the posterior wall of the auricular portion of the

heart than the right auricle. In other words, whilst the left auricle is placed almost completely behind, the right auricle comes, to a certain extent, to the front of the heart in connection with the right part of its base (Fig. 166).

On the outer and posterior aspect of the right auricle (when it is distended), a faint furrow descends from the upper part of the base of the auricular appendix over the back of the atrium towards the auriculo-ventricular groove. This is the *sulcus terminalis* of His. It has an embryological significance (Fig. 162, p. 29).

The Ventricular Part of the heart is firm to the touch and possesses thick fleshy walls. It is very distinctly conical in form. Its apex corresponds to the apex of the heart; whilst its base is connected above with the two atria of the auricular part of the heart, and gives origin in front of these, and in the interval between the auricular appendices, to the two great arteries which conduct the blood from the ventricular chambers, viz., the pulmonary artery in front and the aorta behind.

In addition to the base and apex, the ventricular part of the heart presents two borders and two surfaces. The *right border* is long and sharp, and is directed obliquely from right to left, from the base to the apex. It is called the *margo acutus.* The *left border* or *margo obtusus* is short, thick, and rounded.

The *anterior surface* (facies sternalis) of the ventricular part of the heart is full and convex, and is traversed by a groove which begins above at the auriculo-ventricular furrow immediately to the left of the origin of the pulmonary artery, and proceeds downwards towards the right sharp margin, which it reaches a little to the right of the apex. This groove is the *anterior interventricular furrow* (sulcus longitudinalis anterior), and it is placed much nearer to the left margin than to the right margin of the heart. The *posterior surface* (facies diaphragmatica) is flattened and traversed by a similar groove, the *posterior interventricular furrow* (sulcus

longitudinalis posterior). This joins the anterior groove below, round the right sharp margin of the heart, and is placed nearer the right than the left margin. These grooves are occupied by vessels and lodge a little fat. They indicate on the surface the anterior and posterior attachments of the interventricular septum, and therefore the extent of the walls of the two cavities. Roughly speaking, two-thirds of the anterior surface, the margo acutus, and rather more than one-third of the posterior surface, belong to the right ventricle; whilst one-third of the anterior surface, the margo obtusus, the apex of the heart, and rather less than two-thirds of the posterior surface, belong to the left ventricle. On the anterior surface of the heart a bulging of the wall of the right ventricle will be noticed in its upper and front part. This is termed the *infundibulum* or *conus arteriosus*. From its summit the pulmonary artery takes origin.

Dissection.—The vessels and nerves which are distributed to the substance of the heart may now be dissected. The main trunks occupy the furrows, and can be exposed by removing the epicardium and the soft fat which is generally placed around them. In a young subject, where the fat is scanty and the vessels well injected, very little dissection is required. The nerves are exceedingly delicate and derived from the cardiac plexus. It is seldom that they can be satisfactorily displayed in an ordinary dissecting room subject.

The Coronary Arteries are the nutrient vessels of the heart. They are two in number, and spring from the root of the ascending aorta. It is here, therefore, that they must in the first instance be sought, by dissecting deeply in the auriculo-ventricular furrow. The *left coronary artery* (arteria coronaria sinistra) springs from the left posterior sinus of Valsalva,[1] and proceeds outwards behind the pulmonary artery. It winds round the left side of the heart (ramus circumflexus), and ends on its posterior aspect. Throughout its entire course it lies in the auriculo-ventricular

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[1] The three sinuses of Valsalva are three bulgings of the wall of the aortic root. One is on the front, and the other two on the back of the vessel.

furrow. It gives off numerous twigs to the left auricle and left ventricle, and one large branch will be observed to pass downwards in the anterior interventricular groove towards the apex of the heart (ramus descendens).

The *right coronary artery* (arteria coronaria dextra) arises from the anterior sinus of Valsalva, and winds round the right margin of the heart in the auriculo-ventricular groove to reach its posterior aspect, where it ends near the termination of the artery of the left side. An arterial circle is thus formed, which embraces the base of the heart. The right coronary artery gives off two large branches. Of these, one passes downwards upon the right sharp margin of the heart, whilst the second and larger descends towards the apex in the posterior interventricular groove (ramus descendens). It also supplies numerous smaller twigs to the right ventricle and right auricle.

Cardiac Veins (venæ cordis).—Take hold of the heart by the apex and pull it upwards, so as to bring into view its posterior surface. In the groove between the left ventricle and left auricle—the *coronary sinus* (sinus coronarius)—a short wide venous channel will be seen. Open it with the scissors along its whole length. By one extremity it opens into the right auricle, whilst by its other end it becomes continuous with the *great cardiac vein*, and the point of junction is marked by a valve of two segments. Several *posterior cardiac veins* from the posterior aspect of the ventricles also open into this sinus, and each orifice is guarded by a distinct valve. Of these, one much larger than the others, and called the *middle cardiac vein* (vena cordis media), ascends in the posterior interventricular groove. The *right* or *small coronary vein* (vena cordis parva) likewise joins the coronary sinus close to its termination. It occupies that part of the auriculo-ventricular furrow which, on the posterior surface of the heart, intervenes between the right auricle and right ventricle. Lastly, the *oblique vein of Marshall* (vena obliqua atrii sinistra) from the back of the left auricle opens into the sinus close to the point where it joins the right auricle. The orifice of this

vein is devoid of a valve. The oblique vein is very minute, and would not deserve special mention, were it not that it represents the lower pervious part of the obliterated left superior vena cava of the embryo.

The *great cardiac vein* (vena cordis magna) begins upon the anterior aspect of the heart at the apex. It ascends in the anterior interventricular groove to the auriculo-ventricular furrow, in which it turns round the left margin of the heart to join the coronary sinus. On its way it is joined by numerous veins from the surface of both the ventricular and auricular parts of the heart.

The *anterior cardiac veins* will be seen on the front surface of the right ventricle. They open directly into the right auricle.

But, in addition to those veins which appear upon the surface, there are minute vessels in the substance of the heart—the *venæ Thebesii* or *venæ minimæ cordæ*—the orifices of which will be recognised, when the right auricle is opened, as the foramina Thebesii.

The cardiac veins, therefore, which drain the blood from the heart, do not correspond with the arteries. The following table expresses the arrangement in a brief form :

Upon the surface of the heart.	Great cardiac vein. Posterior cardiac veins. Right cardiac vein. Oblique vein.	*Opening into* coronary sinus.
	Anterior cardiac veins.	*Opening into* right auricle.
In the substance of the heart.	Vena Thebesii.	*Opening into* right auricle.

It is only in a heart which has been specially injected that all these veins can be seen. The general arrangement, however, can usually be studied in the course of an ordinary dissection. In certain cases, where the veins are empty and the fat on the surface of the heart scanty, they may be inflated with air by introducing a blow-pipe into some of the larger members of the series.

Cardiac Nerves.—For the most part the fine nerves which form the superficial cardiac plexus are prolonged downwards,

and receiving close to the heart a considerable reinforcement from the deep cardiac plexus, they form the *right coronary plexus* which comes into relation with the corresponding artery. The *left coronary plexus* which accompanies the artery of the same name is derived from the deep cardiac plexus. The nerves do not slavishly follow the arteries, they soon leave the vessels, and are ultimately lost in the substance of the heart. Here and there ganglia are developed in connection with them.

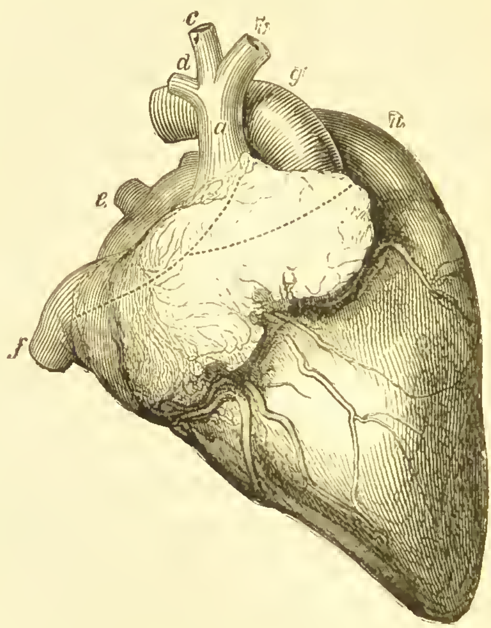

FIG. 169.—Diagram to show the manner in which the right auricle should be opened. The drawing is taken from an injected heart in the Edinburgh University. The dotted lines give the directions in which the two incisions should be made. *a*, Superior vena cava; *b*, Left innominate vein; *c*, Right innominate vein; *d*, Vena azygos major; *e*, One of the pulmonary veins; *f*, Inferior vena cava; *g*, Aortic arch; *h*, Pulmonary artery.

Dissection.—The chambers of the heart should now be opened in the order in which the blood flows through them. Begin with the right auricle, and, to bring it fully into view, draw the heart well over to the left side of the body. Fig. 169 shows the direction in which the incisions through its walls must be made. Two cuts are required—(1) A vertical incision from the point at which the superior vena cava enters the auricle to the point of entrance of the inferior vena cava. In making this incision, care must be taken not to injure the Eustachian valve—a fold of endocardium placed in front of the mouth of the inferior vena cava. (2) An oblique incision carried from about the middle of the first cut to the tip of the auricular appendix. The dark venous blood should now be washed away from the interior of the auricle with a sponge.

When the dissector has fully studied the interior of the right auricle, he may slit open with the scissors the superior vena cava and the two innominate veins. By this proceeding he may satisfy himself that *no valves* are present in these vessels.

Right Auricle.—The internal surface of the cavity presents a smooth glossy appearance, due to its endocardial lining. In the auricular appendix the wall is raised into a series of closely applied parallel ridges, called the *musculi pectinati*, from their resemblance to the teeth of a comb. These ridges are also present on the right wall of the auricle, and when followed backwards they are seen to end on a smooth vertical ridge, called the *crista terminalis* (His). (Fig. 162, p. 29.) It represents in the interior of the auricle the groove on the exterior already described under the name of the sulcus terminalis. In the intervals between the musculi pectinati the wall of the auricle is very thin.

The blood enters the atrium of the auricle by the following openings:—(1) the opening of the superior vena cava; (2) the opening of the inferior vena cava; (3) the opening of the coronary sinus; (4) the orifices of three or four anterior cardiac veins from the surface of the right ventricle; (5) the foramina Thebesii.

The blood flows out of the cavity, into the right ventricle, through the large auriculo-ventricular opening.

The orifice of the *superior vena cava* is situated at the upper part of the auricle. The *inferior vena cava* opens into the lower part of the cavity. The dissector should note that these two veins are so directed that the currents of blood, which flow from them into the auricle, shall not be opposed the one against the other. The blood of the superior vena cava is directed towards the auriculo-ventricular opening, whilst the stream of blood flowing from the mouth of the inferior vena cava is directed so as to impinge against the septum between the auricles.

The *auriculo-ventricular orifice* is the large, oval opening situated in the lower part or floor of the auricle. Through

this aperture three fingers can be readily passed into the ventricle. If the student now looks between this opening and the orifice of the inferior vena cava, he will discover the mouth of the *coronary sinus*, imperfectly guarded by a fold of endocardium, which receives the name of the *coronary valve* or *valve of Thebesius.* An attentive examination of the inner surface of the auricular wall will further reveal several minute, round, irregularly scattered openings called the *foramina Thebesii.* Some of these are simply small cæcal pits in the substance of the heart, whilst others are the mouths of minute veins—the *venæ Thebesii.*

Examine, in the next place, the posterior wall of the right auricle. It is formed by the partition which separates the two auricles from each other (*septum atriorum*). Upon this an oval depression, surrounded by a prominent ridge, will be noticed a short distance above the mouth of the inferior vena cava. The depression is called the *fossa ovalis.* Its floor is exceedingly thin, and it marks the position of the *foramen ovale* of the fœtal heart. The ridge which encircles it is deficient below. It is, therefore, crescentic in form, and is called the *annulus ovalis* (limbus fossæ ovalis). In a few cases, a communication between the two auricles may be found by slipping a probe under the upper and best-marked part of the annulus. Stretching between the anterior horn of the annulus ovalis and the anterior margin of the mouth of the inferior vena cava is a cresentic fold of endocardium, sometimes cribriform and often very feebly marked, called the *Eustachian valve.*

Dissection.—The right ventricle may now be opened by the following incisions. (1) A vertical incision through the anterior wall of the ventricle about a quarter of an inch to the right of the anterior interventricular furrow. Enter the knife above at the conus arteriosus, and carry it downwards, parallel to the furrow, as far as the right margin of the heart. (2) A transverse incision, through the anterior wall of the ventricle, from the upper end of the first incision to the right margin of the heart. This cut should be made parallel to the auriculo-ventricular groove, and about half an inch below it. Both incisions must be made

with care and deliberation, but more especially the second one. In this case the auriculo-ventricular valve is liable to injury, and it is well to protect it by introducing the forefinger of the left hand through the auriculo-ventricular opening into the ventricle.

The anterior wall of the right ventricle can, in this way, be raised in the form of a V-shaped flap and turned to the right. Wash away the blood and clots.

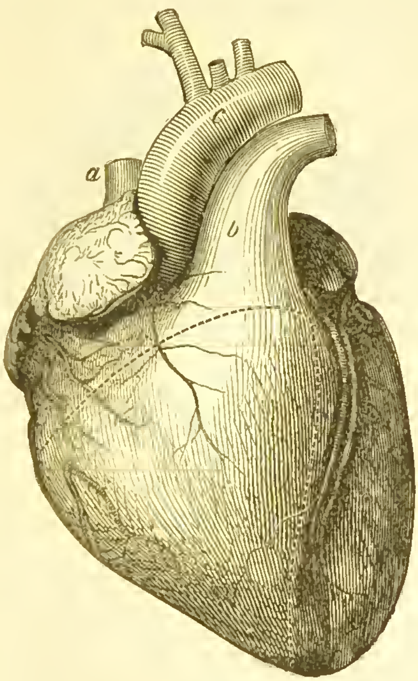

FIG. 170.—Diagram to show the manner in which the right ventricle should be opened. The dotted lines indicate the direction of the incisions. In the anterior interventricular furrow the coronary artery and the great cardiac vein are seen. *a*, Superior vena cava; *b*, Pulmonary artery; *c*, Aorta.

Right Ventricle. — The cavity of the right ventricle, now laid open and exposed to view, is of a somewhat triangular form, the base being directed upwards, and the apex downwards towards the apex of the heart. It does not reach the apex of the heart, however, but corresponds to the junction of the anterior and posterior interventricular furrows around the right sharp margin of the heart. On transverse section, the cavity of the right ventricle is semilunar in outline, owing to the thick fleshy interventricular septum which constitutes its inner and posterior wall bulging into it (Fig. 171). The wall is thickest at its upper part, and thins slightly towards the apex.

With the exception of the conus arteriosus, the interior of which is smooth and even, the inner surface of the walls

of the right ventricle is rendered extremely irregular by the projection of fleshy ridges called *columnæ carneæ* (trabeculæ carneæ). It is customary to describe these as presenting three different forms—(*a*) simple elongated ridges; (*b*) fleshy slips or trabeculæ free throughout the greater part of their extent, but fixed to the wall by their two extremities; (*c*) conical fleshy projections of considerable size, which project into the cavity, and are attached by their bases only. These last are called *musculi papillares*, and are arranged so as to form an anterior and a posterior set. The free end of each of these papillary muscles gives origin to several delicate thread-like tendons—*the chordæ tendineæ*—and by these they are brought into connection with the segments of the auriculo-ventricular valve. A transverse fleshy band will be noticed to spring from the base of the anterior papillary muscle, and stretch across the ventricular cavity to the septum, to which it is attached. This is the *moderator band.* By fixing the yielding anterior wall of the ventricle to the more solid septum, it is said to prevent over distension of the cavity.

FIG. 171.—Transverse section through the ventricular part of the heart. (From LUSCHKA.)

1. Cavity of right ventricle.
2. Cavity of left ventricle.
3. Ventricular septum.
4. Thick wall of left ventricle.
5. Thinner wall of right ventricle.
6. Posterior interventricular furrow with middle cardiac vein and posterior branch of right coronary artery.
7. Anterior interventricular furrow, with great cardiac vein and anterior branch of left coronary artery.

There are two openings in the right ventricle—(1) the *auriculo-ventricular*, which gives admission to the stream of blood; (2) the *pulmonary*, through which the blood passes

into the pulmonary artery. Both these openings are situated at the base of the ventricle. The large oval auriculo-ventricular orifice lies to the right, close to the right margin of the heart, whilst the pulmonary aperture is placed to the left, in front of the other, and at the summit of the conus arteriosus. Both of these openings are guarded by valves, which act so as to give the blood its proper direction through the heart.

The valve which guards the mouth of the pulmonary artery is composed of three semilunar segments, and is called the *semilunar* or the *sigmoid valve.* By looking upwards into the lumen of the artery, a view of these segments may be obtained, but it is better to defer their examination until the vessel itself has been studied.

The Right Auriculo-Ventricular or Tricuspid Valve (valvula tricuspidalis), is composed of three triangular, pointed, membranous segments, termed *cusps*, which hang down into the cavity. These are united by their bases so as to form an annular membrane, and, through the intermediation of this, they are fixed around the auriculo-ventricular opening. In the intervals between these larger segments three smaller cusps may frequently be detected.

Each cusp is composed of two layers of endocardium, between which there is a certain amount of fibrous tissue. This fibrous tissue is, for the most part, confined to the central portion of the cusp, the margins of which are therefore thin and translucent. When the valve is in action, it prevents regurgitation of blood into the auricle during the contraction of the ventricular wall. Attached to the ventricular surface and margin of each segment, as well as into the circumference of the auriculo-ventricular opening, are several of the chordæ tendineæ which have been seen to take origin from the apices of the papillary muscles. In consequence of this, the ventricular surface of the valve is rough, whilst the auricular surface—that surface over which the blood flows—is smooth.

It is necessary, however, to note the relative position of these cusps. One, the largest of the three, is suspended so as to intervene between the auriculo-ventricular opening and the pulmonary orifice. It lies in front and to the left of the opening. This is the *infundibular cusp.* Another is placed posteriorly to the auriculo-ventricular opening, and lies closely applied to the septum. This is the *septal cusp.*

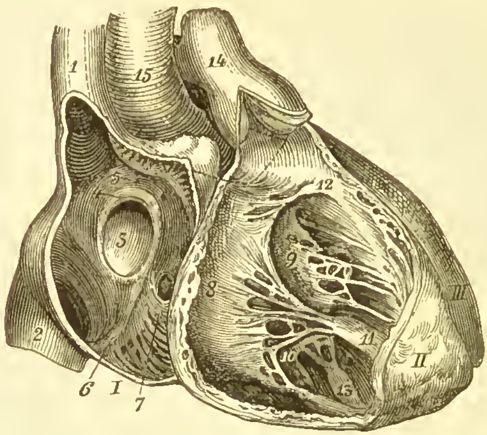

FIG. 172.—Interior of the right auricle and right ventricle. (From LUSCHKA.)

1. Superior vena cava.
2. Inferior vena cava.
3. Fossa ovalis.
4. Annulus ovalis.
5. Foramina Thebesii.
6. Eustachian valve.
7. Opening of coronary sinus.
8. Infundibular cusp of tricuspid valve.
9. Septal cusp.
10. Marginal cusp.
11. Anterior papillary muscle.
12. Small papillary muscle on the septum.
13. Posterior papillary muscle.
14. Pulmonary artery.
15. Aorta.

I. Right auricle; II. Right ventricle; III. Left ventricle.

The third is situated to the right, near the margin of the heart, and may be termed the *marginal cusp.* The chordæ tendineæ of the anterior papillary muscle are distributed in the interval between the infundibular and marginal flaps; those from the posterior papillary muscle go to the interval between the marginal and septal flaps; whilst to the interval

between the infundibular and septal flaps pass a number of short chordæ tendineæ, some of which spring directly from the septum, whilst others proceed from low, feeble, musculi papillares, also connected with the upper part of the septum.

Pulmonary Artery (arteria pulmonalis).—This vessel is a short wide trunk about two inches long. It has an oblique direction upwards and backwards, so as to reach the lower aspect of the aortic arch. It here divides into a *right* and a *left* branch. At first, it lies in front of the root of the aorta, but, before it terminates, it is placed upon the left side of the ascending aorta (Fig. 166, p. 41). In relation to each side of the pulmonary artery the dissector will notice the corresponding coronary artery and auricular appendix. It is almost completely enclosed within the fibrous pericardium, the serous layer of which forms a single tubular sheath around it and the ascending aorta.

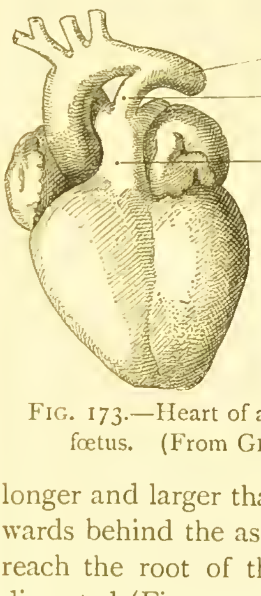

FIG. 173.—Heart of a seven months' fœtus. (From GEGENBAUR.)

The *right pulmonary artery* is somewhat longer and larger than the left. It passes transversely outwards behind the ascending aorta and superior vena cava to reach the root of the right lung, where it has already been dissected (Fig. 177, p. 67). The *left pulmonary artery* runs outwards in front of the descending aorta and left bronchus to gain the root of the left lung (Fig. 177, p. 67). The blood is thus conducted from the right ventricle of the heart to the two lungs.

Obliterated Ductus Arteriosus.—A strong fibrous cord—the *ligamentum arteriosum*—will be observed connecting the upper surface of the root of the left pulmonary artery

with the under surface of the aortic arch. The ligamentum arteriosum has the same direction as the trunk of the pulmonary artery. During fœtal life it is the patent continuation of the pulmonary artery, and conducts the blood into the aorta. At this period, the right and left pulmonary arteries are of small size, and convey a very small part of the blood stream to the lungs. In dissecting the fibrous remains of the ductus arteriosus, note that the left recurrent laryngeal branch of the pneumogastric nerve hooks round it at its attachment to the aorta.

Dissection.—The pulmonary artery may now be slit open, so as to expose the valve which guards its orifice. This incision must be made carefully, and the knife carried upwards through the wall of the vessel in the interval between two of the three segments which enter into its formation.

Pulmonary Valve.—Each semilunar segment will be observed to be attached by its convex margin, whilst its concave border is free. Three minute pouches are thus formed around the mouth of the vessel, and the openings of these pouches are directed upwards. A good idea of the valve may be obtained by filling the pouches with cotton wadding. The segments consist of a double layer of endocardium, strengthened by intermediate fibrous tissue, and if the free margin of one be taken between the finger and thumb, a minute nodule of cartilage may be felt about its middle. This is the *corpus Arantii.* In structure, these little flaps are similar to the corresponding segments of the aortic valve—only weaker. We shall defer their more particular description, therefore, until the aortic valve is under consideration. Opposite each segment, the wall of the artery shows a slight dilatation or bulging, called the *sinus of Valsalva.* The three segments of the pulmonary valve are so placed that two are in front and one behind the opening (Fig. 174).

Pulmonary Veins (venæ pulmonales).—The blood is conveyed back to the heart by the pulmonary veins. These

have already been studied in the roots of the lungs. Two issue from each lung. The *right veins* are longer than the left, and pass inwards behind the superior vena cava and the right auricle. The *left veins* pass in front of the descending

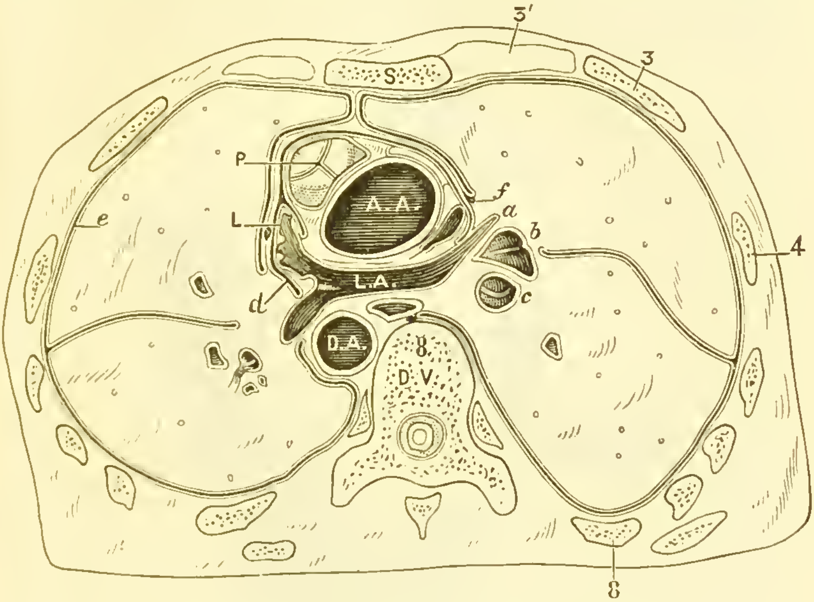

FIG. 174.—Horizontal section of the thorax of a man aged 57 years, looked at from above. (From SYMINGTON.)

8 D.V. Eighth dorsal vertebra, cut across near its upper surface.
S. Body of sternum.
3, 4, 8. Ribs; between 4 and 8 fifth, sixth, and seventh ribs are seen; behind seventh rib, the scapula.
3′. Third costal cartilage.
P. Pulmonary orifice, the three semilunar segments of its valve are seen.
A.A. Ascending aorta. On its right side, the superior vena cava and right auricular appendix.
L.A. Atrium of left auricle.
L. Left auricular appendix.
D.A. Descending aorta; to its right side, the œsophagus.
d. Pericardial cavity.
e. Left pleural cavity.
f. Right phrenic nerve. Left phrenic is seen on left side of left auricular appendix.
a. Right upper pulmonary vein.
b. Right pulmonary artery.
c. Right bronchus.

aorta (Fig. 174). If the inferior vena cava be now divided and the heart turned upwards, the pulmonary veins will be seen opening into the left auricle upon its posterior aspect.

Dissection.—To open the left auricle, the heart must be turned well over to the right side of the body, and its apex tilted forwards. Fig. 175 shows the incision which should be made through its wall in order to display its interior. Enter the knife well back, and carry it obliquely forwards into the auricular appendix. The cavity is usually more or less distended with injection, and after this has been removed the walls should be washed with warm water.

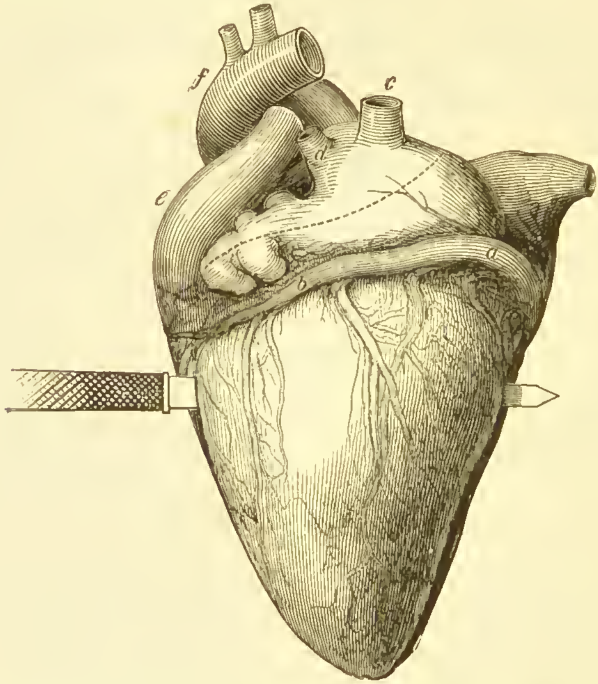

FIG. 175.—Diagram to show the manner in which the left auricle and left ventricle should be opened. The dotted line gives the direction in which the incision through the wall of the auricle should be made. *a*, coronary sinus; *b*, great cardiac vein; *c* and *d*, the two left pulmonary veins; *e*, pulmonary artery; *f*, aortic arch.

Left Auricle.—The only part of the left auricle which can be seen from the front is its appendix. This is narrower and more elongated than the corresponding portion of the right auricle. Its margin also is more distinctly notched. When laid open it will be seen that the *musculi pectinati* are confined entirely to the appendix. Everywhere else the

inner surface of the wall of the left auricle is smooth. On the posterior wall the four openings of the *pulmonary veins* will be seen. In some cases the two pulmonary veins of one or both sides unite before opening into the left auricle. The number of venous orifices is thus reduced. They are not provided with valves. In the lower and fore part of the auricle is the oval *auriculo-ventricular opening.* It only admits the passage of two fingers into the ventricle, and is, therefore, smaller than the corresponding orifice of the right side. The position of the fœtal *foramen ovale* can also be distinguished upon this side of the septum atriorum, but it is not so well marked as it is in the right auricle. It presents the appearance of a faint depression bounded below by a slightly marked crescentic border.

Dissection.—To open the left ventricle, the dissector should stand upon the right side of the body and grasp the heart with the left hand, so that the forefinger rests upon the upper part of the posterior interventricular furrow, and the thumb upon the upper part of the anterior interventricular furrow. The wall of the ventricle should then be transfixed by a long knife (Fig. 175). Enter the knife below the thumb, about half-an-inch to the left of the anterior furrow, and push it through the ventricular wall towards the forefinger, so that the point emerges below this, and half-an-inch to the left of the posterior furrow. Now carry the knife downwards towards the apex, but do not allow it to come nearer to the furrows than it was when first entered. If necessary, the cut on each side may be extended upwards towards the base of the ventricle with a small knife.

Left Ventricle.—The cavity of the left ventricle is longer and narrower than that of the right ventricle. It reaches down to the apex of the heart, and is somewhat conical in shape—tapering towards its lower end. In cross section it presents a circular or broadly oval outline (Fig. 171, p. 53). The walls of the left ventricle are very much thicker than those of the right ventricle.

When the injection and blood have been washed away from the interior of the left ventricle with hot water, the *columnæ carneæ* will be observed to form dense reticulations on the inner surface of its walls. This network is especially

complicated at the apex and on the posterior wall of the cavity. The surface of the septum and the upper part of the anterior wall are, comparatively speaking, smooth. The *musculi papillares*, with their attached chordæ tendineæ, are collected into two strongly marked groups. They are much larger than the papillary muscles of the right ventricle, but do not project so distinctly into the cavity.

The left ventricle has two openings—(1) the auriculo-ventricular opening, through which the blood enters from the auricle; (2) the aortic orifice, through which the blood flows into the aorta. These apertures are situated close together at the base of the ventricle, the *auriculo-ventricular opening* lying behind and to the left, whilst the *aortic orifice* is placed in front and to the right. Both openings are guarded by valves—the auriculo-ventricular opening by the *mitral* or *bicuspid valve*, and the aortic opening by the *aortic valve.*

The Mitral Valve (valvula bicuspidalis s. mitralis) prevents regurgitation of the blood into the left auricle during the contraction or systole of the ventricle. It consists of two large pointed cusps with two smaller portions intervening. These are similar in structure to the cusps of the tricuspid valve, but the segments are larger and much stronger and thicker. The fibrous tissue between the two layers of endocardium is more abundant, but it is arranged in precisely the same manner. The chordæ tendineæ from each musculus papillaris proceed to one of the two intervals between the cusps, and are attached to the adjacent margins and to the ventricular surfaces of the two cusps. The *anterior cusp* is the larger of the two, and lies in front and to the right of the opening, being so placed as to intervene between the auriculo-ventricular and the aortic apertures. The *posterior cusp* lies behind and to the left of the opening.

Aortic Opening.—The part of the ventricular cavity immediately below the orifice of the aorta has been termed the *aortic vestibule* (Sibson). Its walls are not muscular but fibrous, and therefore it does not collapse during the diastole

of the ventricular part of the heart. This is of advantage in so far that it affords space for the proper action of the aortic valve.

Looking upwards into the circular mouth of the aorta, the *aortic valve* will be seen. It is similar in all respects to the pulmonary valve, only its segments are stronger and thicker, and the sinuses of Valsalva at the root of the aorta are more strongly marked. The aortic valve will be studied more fully at a later stage of the dissection.

Septum Ventriculorum.—The septum between the two ventricles is a thick fleshy partition,—the anterior and posterior attachments of which are indicated on the surface of the heart by the anterior and posterior interventricular furrows. Now that both surfaces of the septum are exposed, it will be seen to be thickest near the apex of the heart, and to thin slightly in an upward direction. In its upper and fore part a small portion may be noted which is completely destitute of muscular tissue, and which consists merely of the two layers of endocardium, with some intervening fibrous tissue. This portion is termed the *pars membranacea septi*, and it is of interest from the fact that it is at this point that congenital deficiency of the septum is most liable to occur. The pars membranacea septi forms a portion of the wall of the aortic vestibule, and lies immediately below the contiguous ends of the anterior and right posterior flaps of the aortic valve.

Action of the Heart.—The above details will be dry and meaningless unless they are looked at in connection with the action of the heart during life. It is impossible to understand the construction of the heart unless we study at the same time its function. During life, the blood is driven through and from the heart by means of successive rhythmical contractions and dilatations of its walls. But the entire heart does not act simultaneously. First, the auricles contract together, and this is succeeded by the contraction of the ventricles ; in other words, the auricular contractions correspond to the ventricular dilatations, and *vice versâ*. But, again, there is a period immediately preceding the auricular contraction, during which the entire heart is at rest,

and this is called the period of cardiac rest. These three conditions the walls of the heart, viz.—(*a*) the cardiac rest, (*b*) the auricular contraction, (*c*) the ventricular contraction—follow each other consecutively and without intermission, the one after the other ; and they are collectively termed "a cardiac revolution." Let us study what is going on inside the heart during each of these three stages.

During the *period of cardiac rest* the auricles are filling. Blood is flowing into the right auricle through the openings of the superior vena cava, inferior vena cava, and the coronary sinus ; and into the left auricle through the orifices of the four pulmonary veins. A portion of this blood trickles down through the auriculo-ventricular openings into the ventricles ; but the blood is passing into the auricles in greater quantity than it is trickling into the ventricles, and the result is, distension of the auricles. The second stage of the cardiac revolution now takes place—viz., *the auricular contraction.* The auricles contract sharply and suddenly, and the blood is forced through the auriculo-ventricular orifices into the ventricles. But how is it that the blood, during this contraction, does not regurgitate into the veins, the mouths of which are devoid of valves? For the simple reason that the contraction begins at the venous orifices and auricular appendices, and travels towards the auriculo-ventricular openings. The ventricles are now full, and the third stage of the cardiac revolution takes place—viz., *the ventricular contraction.* The ventricles contract more slowly, and more deliberately than the auricles, and the blood is discharged into the pulmonary artery and into the aorta. Regurgitation of blood through the auriculo-ventriclar openings into the auricles is prevented by the apposition of the segments of the tricuspid and bicuspid valves, and when the ventricular contraction ceases, regurgitation from the arteries into the ventricles is prevented by the semilunar valves being thrown across the arterial orifices.

Thc segments of the auriculo-ventricular valves are retained in position, and prevented from being forced upwards into the auricle during the ventricular contraction by the musculi papillares and the chordæ tendineæ. As the ventricular wall in its contraction to a certain extent advanccs towards the auriculo-ventricular opening, the musculi papillares, in their contraction, retreat from it, and keep the tendinous cords tense—never allowing them to slacken. When the contraction of the ventricle ceases, and the *vis a tergo* is removed from the blood, the recoil of the expanded wall of the artery exerts a pressure upon the column of blood. Its backward flow is prevented by the filling of the pouches of the semilunar valve.

Topography of the Cardiac Orifices.—The position of the different cardiac orifices, with reference to the anterior wall of the chest, is a

matter of some importance. The *pulmonary aperture* is the most superficial, and lies behind the upper part of the junction of the third left costal cartilage with the left margin of the sternum. The pulmonary artery itself lies behind the anterior end of the second left intercostal space. The *aortic opening* is placed more deeply and at a slightly lower level. It is situated behind the left margin of the sternum opposite the lower border of the junction, between the third left costal cartilage and the sternum. The *right auriculo-ventricular orifice* lies behind the sternum, close to the extremity of the fourth intercostal space of the right side. The *left auriculo-ventricular opening* is very deeply placed. It is situated behind the left margin of the sternum at the level of its junction with the fourth left costal cartilage.

Dissection.—The aorta should now be examined, and the various structures in relation to it must be carefully dissected out.

The Aorta.—The aorta is the great arterial trunk which conveys blood from the left ventricle of the heart, and distributes it by means of its branches to every part of the body. After leaving the heart it arches over the root of the left lung, and proceeds downwards in front of the vertebral column. It leaves the thoracic cavity by passing through a special opening in the diaphragm, and it ends in the abdominal cavity upon the left side of the body of the fourth lumbar vertebra, by dividing into the two common iliac arteries. The part of this great vessel which is contained within the chest is divided, for convenience in description, into three portions: viz., *the ascending aorta*, the *arch of the aorta*, and the *descending thoracic aorta.*

The *ascending aorta* takes origin from the base of the left ventricle of the heart, and proceeds obliquely upwards and to the right behind the sternum. It also inclines, to some extent, forwards, so as to approach more closely to the anterior wall of the chest. Reaching the upper border of the *second costal cartilage* of the *right side*, it changes its direction, and passes into the aortic arch. In the first instance the *aortic arch* bends upwards and to the left in front of the trachea, and then turns suddenly backwards so as to gain the lower border of the body of *the fourth dorsal vertebra.* Here the vessel makes a bend in a downward

direction, and becomes continuous with the *descending thoracic aorta.*

The Ascending Aorta (aorta ascendens) extends from the base of the left ventricle, in a curved direction, to the upper border of the second right costal cartilage. For the most part it lies behind the sternum, but it projects slightly beyond the right margin of the bone at the level of the second intercostal space. Throughout almost its entire length it is enclosed within the fibrous pericardium, whilst the same sheath of serous pericardium surrounds it and the pulmonary artery. It is, therefore, placed within the middle mediastinum (Figs. 174 and 177, p. 57 and 67).

It does not possess a uniform diameter. At its root, opposite the segments of the aortic valve, it presents the three bulgings termed the sinuses of Valsalva ; whilst higher up, on cross section, it generally exhibits a transversely oval and not a circular outline. This is due to the presence of a diffuse bulging of the right wall, which receives the name of the *great aortic sinus.* Against the wall of this sinus the blood is driven with great force as it leaves the ventricle, and at first sight it might seem to be aneurismal in its origin, but its presence in the fœtus renders such a view untenable. It is, however, a very favourite site for aneurismal dilatation.

The more immediate relations of the ascending aorta may now be examined. It is intimately associated with the pulmonary artery throughout its entire length. At its origin it lies behind the root of the pulmonary artery ; higher up, this vessel is placed to the left of the ascending aorta. To its right side is the superior vena cava, whilst behind, it is in relation to the left auricle and the right pulmonary artery (Figs. 174 and 177). It is overlapped by the right pleura and the anterior thin margin of the right lung, which intervene between it and the chest wall.

The *coronary arteries* have already been seen to spring from this portion of the aorta.

The Aortic Arch (arcus aortæ) extends from the upper border of the second right costal cartilage to the left side of

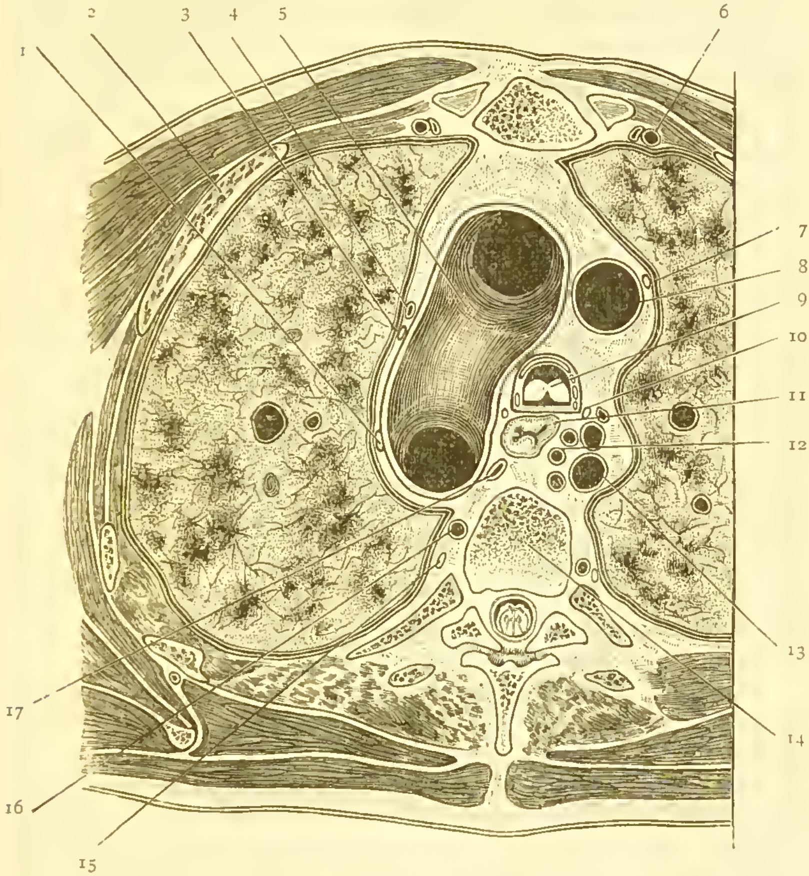

FIG. 176.—Transverse section through the thorax at the level of the fourth dorsal vertebra. This figure, and figure 8, Vol. I., p. 29, are taken from the same specimen, and fit together.

1. Left pneumogastric nerve.
2. Second rib.
3. Left phrenic nerve.
4. Left superior intercostal vein.
5. Transverse part of the aortic arch.
6. Internal mammary vessels.
7. Right phrenic nerve.
8. Superior vena cava.
9. Trachea.
10. Right pneumogastric.
11. Œsophagus.
12. Upper aortic intercostal arteries.
13. Vena azygos major.
14. Body of fourth dorsal vertebra.
15. Sympathetic cord.
16. Vena azygos minor superior.
17. Thoracic duct.

the body of the fourth dorsal vertebra. It is placed within the superior mediastinum, and the left pleura is applied to its left aspect throughout almost its entire extent (Fig. 176). It lies behind the manubrium sterni, and is crossed, under cover of the left mediastinal pleura, by the left phrenic nerve, the inferior cardiac branch of the left pneumogastric nerve, the left superior cardiac branch of the sympathetic, the left pneumogastric nerve, and the left superior intercostal vein, in that order from before backwards. At first the aortic arch lies in front of the trachea; afterwards it is placed to the left of the trachea, the œsophagus, thoracic duct, and the left recurrent laryngeal nerve (Fig. 176). The *upper border* of this subdivision of the aorta is in relation to the left vena innominata, and from this aspect of the vessel three large arteries take origin, viz., from right to left—(*a*) the innominate, (*b*) the left common carotid, and (*c*) the left subclavian. Its *lower surface*, which forms the concavity of the arch, overhangs the bifurcation of the pulmonary artery, and is connected with the root of the left pulmonary artery by the fibrous ligamentum arteriosum. Hooking round this surface is the recurrent laryngeal branch of the left vagus nerve.

Dissection.—The three large branches which spring from the aortic arch carry blood for the supply of the two upper limbs and the head and neck. They should now be dissected. The left common carotid takes origin somewhat nearer the innominate artery than the left subclavian. They are all contained within the superior mediastinum, and Fig. 176, p. 68, which is taken from a tracing of a transverse section through the upper part of this space a short distance above the level of the aortic arch, shows their more important relations.

The Innominate Artery (arteria anonyma).—The innominate artery is the largest of the three branches which spring from the aortic arch. It passes obliquely upwards and to the right, and, gaining the posterior aspect of the right sterno-clavicular articulation, ends behind the upper margin of the clavicle, by dividing into the right common carotid and right subclavian arteries. *In front* of the vessel is the manubrium sterni, to the posterior aspect of which

are attached the sterno-hyoid and sterno-thyroid muscles. Further, the artery is crossed superficially, and close to its origin, by the left vena innominata. *Behind* is the trachea; but as the vessel inclines to the right, it comes to lie, at a

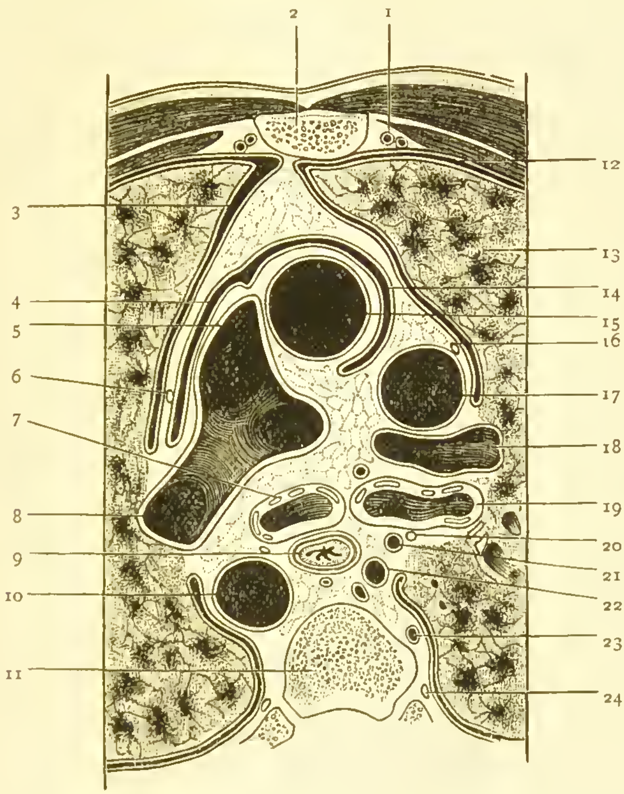

FIG. 177.—Section through the mediastinal space at the level of the fifth dorsal vertebra.

1. Internal mammary vessels.
2. Sternum.
3. Left pleural cavity.
4. Pericardium.
5. Pulmonary artery.
6. Left phrenic nerve.
7. Left bronchus.
8. Left pulmonary artery.
9. Œsophagus.
10. Descending part of aortic arch.
11. Fifth dorsal vertebra.
12. Right pleural cavity.
13. Right lung.
14. Pericardium.
15. Ascending aorta.
16. Right phrenic nerve.
17. Superior vena cava.
18. Right pulmonary artery.
19. Right bronchus.
20. Right pneumogastric nerve.
21. Bronchial artery.
22. Vena azygos major.
23. Intercostal artery.
24. Sympathetic cord.

higher level, upon the right side of the windpipe. To the *right side* of the artery, in its upper part, are the pleura, the right innominate vein, and the right phrenic nerve.

With the exception of the two trunks into which it divides, the innominate artery gives off no branches. The *thyroidea ima*, an occasional artery, may be seen to spring from it in some cases.

Left Common Carotid Artery.—This artery ascends to the posterior aspect of the left sterno-clavicular articulation.

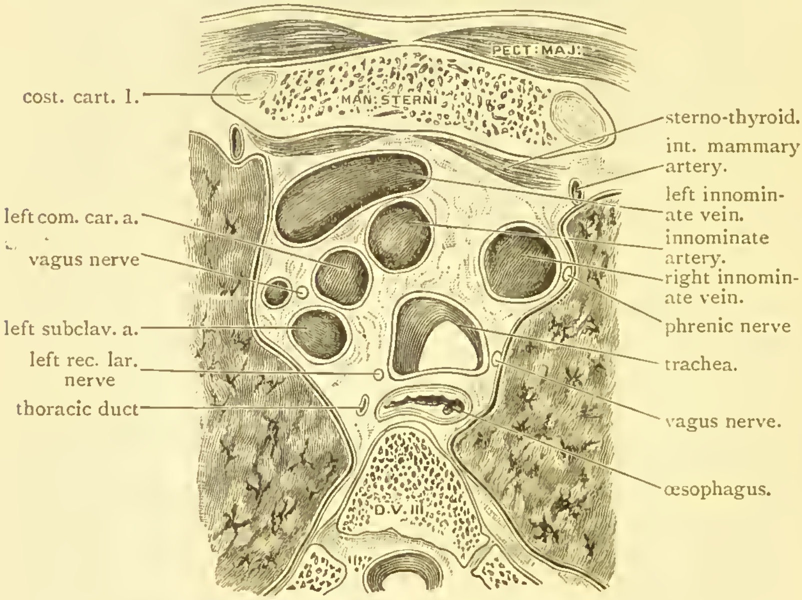

FIG. 178.—Transverse section through the superior mediastinum at the level of the third dorsal vertebra.

At this point it leaves the thorax and enters the neck. It lies deeply in the thorax, at a greater distance from the manubrium sterni than the innominate artery. *In front* of this vessel are the remains of the thymus gland, and the left vena innominata, which crosses it. *Behind*, it is in relation, in the first instance, to the trachea, and higher up to the œsophagus and thoracic duct. To its *left side* is the left vagus

nerve. Further, it is supported on the left side by the left pleura and lung. It gives off no branches within the thoracic cavity.

The Left Subclavian Artery, which springs from the aortic arch, near its termination, lies very deeply in the superior mediastinum. It takes a vertical course upwards towards the thoracic inlet, through which it passes by arching outwards over the cervical pleura and apex of the left lung to gain the upper surface of the first rib. *In front* is the left common carotid artery, the left vena innominata, and the left pneumogastric nerve. To *its right side* are the trachea and the left recurrent laryngeal nerve, and higher up, the œsophagus and thoracic duct. *Behind* and to *its left side* are the left mediastinal pleura and the left lung. In other words, the artery lies in a groove on the inner aspect of the apex of the left lung, and, before the dissection of the mediastinum, if the apex of the lung be pulled outwards, the injected artery will be seen to bulge into the pleural cavity (Fig. 178).

Dissection.—The deep cardiac plexus should now be dissected. Divide the aortic arch at its commencement and termination. Two ligatures should be placed around the vessel at each of these points and the section made between them. This is done to prevent the escape of the injection with which the artery is filled. The superior vena cava may also be severed immediately below the point where it is joined by the vena azygos major. By cutting the fibrous ductus arteriosus the aortic arch can be drawn aside so as to expose the trachea and the cardiac nerves in relation to it.

Cardiac Plexus.—There are three large nerve plexuses, formed in front of the vertebral column, in connection with the sympathetic system. One of these, the *cardiac plexus*, is situated within the thorax; the other two, the *solar* and the *hypogastric* with its pelvic prolongations, are placed within the abdomen.

The *cardiac plexus* is subdivided into a *superficial* and a *deep* portion, but these are in direct connection with each other, and are to be regarded merely as different parts of

one plexus. The *deep cardiac plexus* is further massed in two portions—a right and a left—which are united across the middle line by many communicating filaments.

The *superficial cardiac plexus* is small in comparison with the deep plexus. It has already been examined, and has been observed to lie in the concavity of the aortic arch in front of the bifurcation of the pulmonary artery. The *deep cardiac plexus* is situated behind the aortic arch upon the lower end of the trachea. It is therefore placed on a deeper plane and at a higher level than the superficial plexus. The branches which enter the different parts of the cardiac plexus are derived from the cervical portions of the gangliated cords of the sympathetic, from the pneumogastric nerves, and from the recurrent laryngeal nerves.

The *sympathetic cardiac branches* are three in number on each side—one from each cervical ganglion—and they are termed respectively, the *upper*, *middle*, and *lower sympathetic cardiac branches.* The *upper* sympathetic cardiac branch of the left side has already been traced across the aortic arch into the superficial cardiac plexus.

The *middle* and *lower* branches of the left side enter the thorax between the left subclavian and left common carotid arteries, and join the left portion of the deep cardiac plexus on the trachea. The *three* sympathetic cardiac branches of the *right side* join the right portion of the deep plexus. As they enter the thoracic inlet they pass behind the subclavian artery; in some cases, however, the upper and middle nerves may be noticed to pass in front of that vessel. Within the thorax they run obliquely downwards and inwards behind the innominate artery to reach their destination on the side of the trachea.

The cardiac branches of the pneumogastric nerves are given off partly in the neck and partly in the thorax. The *cervical branches*, with the exception of the lowest on each side, as a rule, join the sympathetic cardiac branches, and thus lose their identity. The *lowest cervical cardiac branch*

of the left pneumogastric has been previously traced over the aortic arch into the superficial cardiac plexus. The corresponding branch on the right side proceeds downwards in relation to the innominate artery, and joins the right portion of the deep cardiac plexus.

Thoracic cardiac branches are only given off from the trunk of the right pneumogastric. They join the right portion of the deep plexus.

The recurrent laryngeal branches of the pneumogastric nerves also supply cardiac twigs to the deep plexus. *On the left side*, where the recurrent laryngeal hooks round the arch of the aorta, these branches are more numerous, and replace the thoracic cardiac branches of the left pneumogastric. The following table shows the arrangement of the cardiac nerves with reference to the plexus :—

Superficial cardiac plexus, . .	1. Superior cardiac branch of sympathetic of left side. 2. Lowest cervical cardiac branch of left pneumogastric.
Left portion of the deep cardiac plexus, ...	1. Middle and lower cardiac branches of the sympathetic of left side. 2. Upper two cervical cardiac branches of the pneumogastric. 3. Cardiac branches of the left recurrent laryngeal.
Right portion of the deep cardiac plexus, ...	1. Three cardiac branches of sympathetic of right side. 2. Cervical cardiac branches of the pneumogastric. 3. Thoracic cardiac branches of the pneumogastric. 4. Cardiac branches of the right recurrent laryngeal.

The manner in which the different offsets from the cardiac plexus are distributed has, to a certain extent, been examined. From the right portion of the deep plexus proceed—(1) an offset to join the right anterior pulmonary plexus ; (2) an

offset for the supply of filaments to the right auricle of the heart; and (3) a very considerable prolongation, which passes downwards in front of the right pulmonary artery to join the superficial cardiac plexus, and form the *right coronary plexus* (p. 48).

From the left portion of the deep cardiac plexus proceed —(1) an offset to the left auricle; (2) an offset to the left anterior pulmonary plexus; whilst (3) the greater part of it is prolonged downwards in relation to the left pulmonary artery to form the *left coronary plexus* (p. 48).

Removal of the Heart from the Body.—To do this it is only necessary to divide the pulmonary artery and the pulmonary veins. The other vessels have already been severed. The ascending aorta which is attached to the heart should next be slit open, care being taken to carry the knife accurately between two of the segments of the valve so as not to injure either.

The Aortic Valve may now be studied and compared with the pulmonary valve which guards the mouth of the pulmonary artery. The membranous valve segments are three in number, and are of semilunar form. Attached around the opening by their convex margins, their free concave edges project into the lumen of the vessel. Three little pockets, open towards the interior of the artery, are in this manner produced. In the case of the *pulmonary artery* the segments are arranged so that two are in front and one at the back of the orifice. In the aorta, however, one lies at the front and two at the back of the opening, and on looking into the sinuses of Valsalva, which correspond to the segments, the orifices of the coronary arteries will be seen. Note that they are placed, as a rule, opposite the free edges of the corresponding valve segments, and further, that the right artery springs from the anterior sinus of Valsalva, and the left artery from the left posterior sinus of Valsalva. There are no such openings to be seen in the pulmonary artery.

The aortic valve segments are constructed upon a stronger

plan than the pulmonary segments, although in both the structure is the same. In the aortic segments the fibrous tissue which intervenes between the two layers of endocardium is more abundant, and the corpora Arantii more apparent. The fibrous tissue is not uniformly distributed throughout the valve segment, as may be seen by placing one of them on the point of the finger. A firm cord runs along the free edge, and also along the attached border. In addition to this, the fibrous tissue is spread out in the segment in a uniform layer, except in two localities called the *lunulæ.* These are semilunar in outline and lie next the free margin—one on either side of the corpus Arantii. These *lunulæ* are thin and transparent, seeing that they are formed of little more than the two opposed layers of endocardium. When the valve is in action and opposing the return of blood into the heart during diastole of the ventricles, the thin lunular portions of the valve segments are closely applied, and afford mutual support to each other. The full brunt of the blood pressure is borne by the stronger portions of the valve segments.

Cardiac Wall.—The last step in the dissection of the heart consists in the examination of the parts which enter into the formation of the cardiac wall. On the outside, the heart is clothed by *epicardium* or serous pericardium, and on the inside its cavities are lined by the thin smooth *endocardium* which is continuous through the orifices with the lining membrane of the veins and arteries, and takes a large share in the construction of the valve-flaps. Between the epicardium and the endocardium is placed the muscular tissue of the heart, which is termed the *myocardium.* The muscular fibres of the heart are disposed in several layers, in each of which the fibres take a special direction.

But in an ordinary dissecting room heart very little information can be obtained as to the arrangement of the muscular fibres. The continuity of the walls is destroyed by the openings which have been made to obtain a view of the interior of the different chambers. It is better,

therefore, to obtain a fresh sheep's heart. After filling it with a thick mixture of flour and water, it should be boiled for a quarter of an hour. The boiling has the effect of expanding the paste, while at the same time it dissolves the connective tissue, and hardens the muscular fasciculi. When the boiling is completed, the heart should be placed in cold water, and the dissection carried out. The epicardium and the muscular fibres should be torn off without using the cutting edge of the scalpel.

The fibres of the auricles are difficult to dissect; but in the ventricular portion of the heart, the student should be able to make out—(1) that the different layers of muscular fasciculi cross each other obliquely, and are for the most part attached to the fibrous rings which encircle the auriculo-ventricular openings; (2) that the superficial fasciculi are common to both ventricles; (3) that the majority of the fasciculi of the left ventricle bend inwards at the ventricular septum; and (4) that a remarkable spiral or whorled arrangement of fibres (vortex cordis) occurs at the apex of the heart.

Construction of the Ventricular Orifices.—The heart which is obtained in the dissecting room, however, must not be cast aside, because several very essential and important points may be made out by its further dissection. In the first place, it is easy to determine the relation of the auricles and ventricles. By separating the epicardium from the base of the ventricles and the adjacent part of the auricles, and removing the fat and vessels from the auriculo-ventricular furrow, it will be seen that the muscular tissue which enters into the formation of the ventricular walls is quite distinct from that of the auricular walls. The bond of union between the auricles and ventricles consists of two fibrous rings which surround the auriculo-ventricular openings. By removing the auricles with a pair of scissors these can be more fully displayed. It is to these rings that the triangular auriculo-ventricular valve cusps are attached, and it is from them that they derive the fibrous tissue which intervenes between the two layers of endocardium which form them. Two fibrous rings are also placed around the arterial openings, and supply the strengthening fibrous tissue to the semilunar valve segments.

When the auricles are removed from the ventricles, the relative positions of the orifices at the base of the ventricular portion of the heart can be studied. The auriculo-ventricular openings lie posteriorly and side by side. The aortic opening is placed in front and between them, whilst the pulmonary orifice is situated in front of the aortic opening. A wide interval intervenes between the apertures of the right ventricle: the aortic and left auriculo-ventricular orifices, however, lie close together, and their fibrous rings for a short distance are confluent with each other. In the triangular interval, between the aortic and left auriculo-ventricular opening, there is a mass of fibro-cartilage which stands in intimate connection with the fibrous rings.

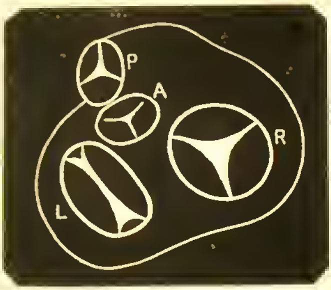

FIG. 179.—Diagram of the base of the ventricular portion of the heart.

P. Pulmonary opening.
A. Aortic opening.
L. Left auriculo-ventricular opening.
R. Right auriculo-ventricular opening.

Dissection.—To expose the trachea more fully, separate the right and left pulmonary arteries with the knife, and throw each outwards towards the lung with which it is connected. The aortic arch must be drawn aside, and some bronchial glands which occupy the angle between the bronchi removed.

Trachea and Bronchi. — The thoracic portion of the trachea, or wind-pipe, traverses the superior mediastinum. It is a wide tube, which is kept constantly patent by a series of cartilaginous rings which are embedded in its walls. Posteriorly these rings are deficient, and in consequence the tube is flattened behind. Its appearance in transverse section may be seen in Fig. 176, p. 65. It begins in the neck opposite the sixth cervical vertebra, where it is continuous with the larynx, and it enters the chest cavity through the thoracic inlet. Here it lies in the superior

mediastinal space, and ends by dividing into the two bronchi opposite the intervertebral disc between the fourth and fifth dorsal vertebræ. Except at its lower end, which is very slightly inclined to the right, it adheres rigorously to the mesial plane.

The relations of the thoracic part of the trachea are as follows: — *In front* — (1) the manubrium sterni, to the posterior aspect of which the sterno-hyoid and sterno-thyroid muscles are attached; (2) the remains of the thymus body; (3) the left innominate vein; (4) the aortic arch and the origins of the innominate and left common carotid arteries; (5) the deep cardiac plexus. *Behind*, it rests upon the œsophagus, which lies somewhat to the left side of the mesial plane. On its *right side* are the pleura and the right pneumogastric nerve, and at a higher level the innominate artery; and on its *left side* are the aortic arch, the left recurrent laryngeal nerve, and the left subclavian artery (Figs. 178 and 176, pp. 68 and 65).

The two bronchi differ considerably from each other. The *right bronchus* is shorter and wider than the left, and appears to be more directly in a line with the trachea. The vena azygos major passes forwards in contact with its upper surface. The superior vena cava and the right pulmonary artery lie in front of it (Fig. 177). The *left bronchus* is longer and narrower than the right. As it passes outwards and downwards it crosses in front of the œsophagus and the descending aorta, and behind the left pulmonary artery (Fig. 177). From its postero-inferior aspect a slender muscular slip may, in some cases, be observed to take origin. This fasciculus connects it with the œsophagus, and is therefore called the *broncho-œsophageal* muscle.

The relations of the bronchi in the roots of the lungs have already been studied (*vide* p. 30).

Posterior Mediastinum.—This term is applied to that part of the interpleural space which lies behind the pericardium. It may be regarded as a continuation downwards

of the posterior part of the superior mediastinum, and many of the structures in the one are prolonged downwards into the other. The arbitrary upper limit of the posterior mediastinum is the lower border of the fourth dorsal vertebra. *In front*, it is bounded by the pericardium, except in its very lowest portion, where the anterior wall is formed by the posterior surface of the diaphragm (Fig. 181). *Behind*, it is limited by the bodies of the dorsal vertebræ below the fourth, and *on each side* by the mediastinal pleura as it passes back from the pericardium to the spine. In transverse section its outline is quadrilateral. Figures 180

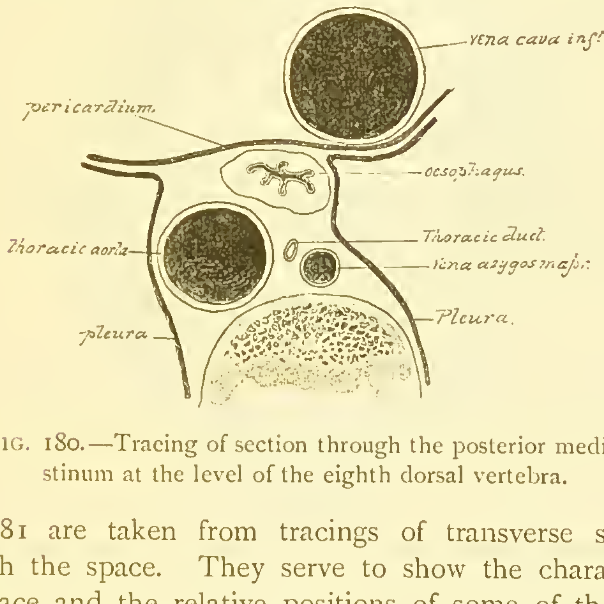

FIG. 180.—Tracing of section through the posterior mediastinum at the level of the eighth dorsal vertebra.

and 181 are taken from tracings of transverse sections through the space. They serve to show the character of the space and the relative positions of some of the more important contents. The following is a list of the structures which it contains:—

1. The descending thoracic aorta.
2. The œsophagus.
3. The pneumogastric nerves.
4. The thoracic duct.
5. The vena azygos major.
6. Certain of the right aortic intercostal arteries.
7. The vena azygos minor superior.
8. The vena azygos minor inferior.
9. The great splanchnic nerves.
10. Some lymphatic glands.

Dissection.—To open into the posterior mediastinal space it is necessary to make a vertical incision through the pericardium, which forms its anterior wall. Carry the knife along the line of the œsophagus, and throw the pericardium outwards. If this be done with care, a fleshy band may, in some cases, be observed crossing the superficial aspect of the thoracic aorta, and extending from the œsophagus to the pleura, which forms the left lateral wall of the posterior mediastinal space. This is the *pleuro-œsophageal muscle.* In the majority of cases, however, this muscle is only represented by a few slender musculi fasciculi which are difficult to isolate from the areolar tissue in which they lie.

Pneumogastric Nerves.—The pneumogastric nerves can now be followed throughout their entire course within the

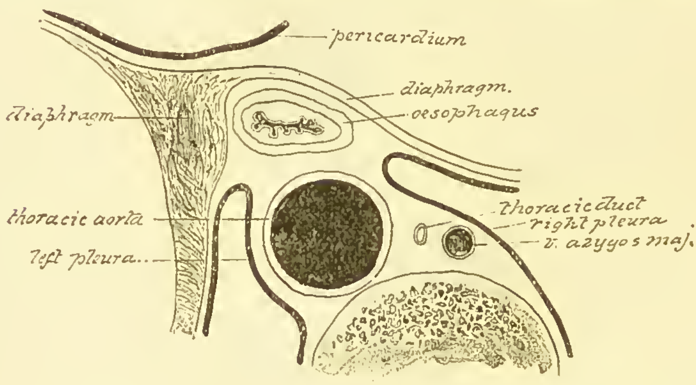

FIG. 181.—Tracing of a section through the lower part of the posterior mediastinum, where its anterior wall is formed by the diaphragm.

thorax. They traverse both the superior and posterior mediastinal spaces, but differ so much in their relations on the two sides of the body that it is best to examine each separately.

The *left pneumogastric nerve* enters the thorax in the interval between the left common carotid and left subclavian arteries, and behind the left innominate vein (Fig. 178, p. 68). It has already been observed crossing the arch of the aorta behind and to the left side of the phrenic nerve and the two superficial cardiac nerves (Fig. 176, p. 65). Here also it has been seen to give off its recurrent laryngeal branch. Leaving

the aorta, it sinks behind the root of the left lung (Figs. 177 and 182), and at once breaks up into a number of branches, which unite in a plexiform manner to form the *left posterior pulmonary plexus.* It issues from this plexus in the form of one or two cords, which pass to the anterior aspect of the

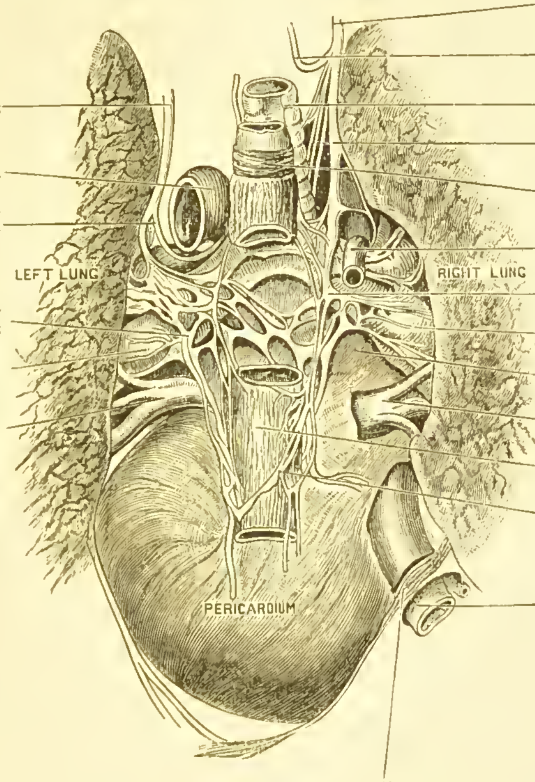

FIG. 182.—Dissection of the roots of the lungs, the pericardium, the pneumogastric nerves, &c., from behind. (By Dr. BROOKS.)

œsophagus. Upon the œsophagus another plexus—the *plexus gulæ*—is formed. Both of the pneumogastric nerves take part in the formation of this plexus. From the plexus gulæ, the left pneumogastric emerges as one trunk, and passes out of the thorax by the œsophageal opening of

the diaphragm. It is distributed within the abdomen upon the anterior surface of the stomach.

The *right pneumogastric nerve*, in the upper part of the superior mediastinum, lies deeper in the thorax than the left nerve. It enters by passing between the subclavian artery and the right innominate vein, and descends by the side of the trachea (Figs. 178 and 176) to the posterior aspect of the root of the right lung (Figs. 177 and 182). Here it breaks up into the *right posterior pulmonary plexus*, and, issuing from this in the form of two nervous cords, it takes part in the formation of the *plexus gulæ.* It leaves this plexus upon the posterior aspect of the œsophagus, and, entering the abdomen through the œsophageal opening of the diaphragm, it is distributed to the stomach upon its posterior surface.

The pneumogastric nerves give off the following branches within the thorax :—

1. Recurrent laryngeal (left side).
2. Thoracic cardiac.
3. Pulmonary.
4. Œsophageal.

The *left recurrent laryngeal* nerve springs from the pneumogastric as it crosses the arch of the aorta. It hooks round the aortic arch, or rather the attachment of the ligamentum arteriosum to the under surface of the arch, and reaching the trachea, ascends by the side of this to the larynx. The *right recurrent laryngeal nerve* arises in the root of the neck, and hooks round the subclavian artery.

The *thoracic cardiac branches* of the right side proceed in part from the pneumogastric and in part from the recurrent laryngeal nerve of that side. On the left side of the body they are derived from the left recurrent laryngeal nerve as it turns round the aortic arch.

The *pulmonary branches* have already been studied in connection with the root of the lung (*vide* p. 28).

The *œsophageal branches* are dispensed to the gullet in two sets—(1) a few delicate twigs are given by the pneumo-

gastric before it enters the pulmonary plexus to that portion of the œsophagus which lies in the superior mediastinum; (2) numerous filaments are supplied by the plexus gulæ to that part of the œsophagus which is placed in the posterior mediastinum.

Œsophagus.—The thoracic portion of the œsophagus should next be studied. It lies partly in the superior mediastinum and partly in the posterior mediastinum. It is the narrowest, but at the same time the most muscular, part of the alimentary canal. It descends in front of the spine, following its antero-posterior curvature, and leaves the thoracic cavity opposite the tenth dorsal vertebra by passing through the œsophageal opening of the diaphragm. The œsophagus does not pursue a straight course through the thorax: it enters somewhat to the left of the middle line; but on tracing it downwards, it will be noticed to incline inwards, so as to assume a mesial position opposite the fifth dorsal vertebra. From this it again deviates to the left so as to gain the œsophageal opening in the diaphragm.

In the superior mediastinum the œsophagus lies immediately behind the trachea (Figs. 178 and 176); below this it is crossed by the left bronchus, with which it is sometimes connected by the broncho-œsophageal muscle (Fig. 177). From this point onwards through the posterior mediastinum it is covered in front by the pericardium, which is applied closely to it (Fig. 180). Just before entering the abdomen it lies behind the posterior part of the diaphragm (Fig. 181). From above downwards, therefore, the immediate anterior relations of the œsophagus are: (1) trachea; (2) left bronchus; (3) pericardium; (4) diaphragm. *Behind*, the gullet lies, except at its lower end, in front of the vertebral column, but there are many structures which intervene between them. Thus, in the superior mediastinum the longus colli muscle separates the gullet from the spine, while in the posterior mediastinum it is placed in front of the vena azygos major and the thoracic duct, and the vena azygos

minor inferior and the right intercostal arteries cross behind it. In its lower part, the gullet inclines forwards and to the left, so that it comes to rest directly upon the anterior surface of the thoracic aorta. These relations are seen in Figs. 180 and 181. Upon the *right side*, during its course through the posterior mediastinum, the œsophagus is clothed by the mediastinal pleura, whilst on the *left side* it is related in the posterior mediastinum to the thoracic aorta, except where in its lower part it lies in front of that vessel (Figs. 180 and 181). In the superior mediastinum the thoracic duct is closely applied to the left side of the œsophagus, and the left pleura comes into partial relationship with it (Fig. 178). Below this, however, it is not directly related to the pleura of the left side.

The pneumogastric nerves form the plexus gulæ on the walls of the gullet, as it traverses the posterior mediastinum, and accompany it in the form of two nerve trunks through the œsophageal opening—the right nerve being placed on its posterior aspect, whilst the left nerve is placed in front of it.

The Descending Thoracic Aorta (aorta thoracica).—The descending thoracic aorta is the direct continuation of the aortic arch, and it traverses the posterior mediastinum. It begins at the lower border of the fourth dorsal vertebra, and ends opposite the last dorsal vertebra by entering the abdomen through the aortic opening of the diaphragm, and becoming the abdominal aorta. At its commencement it lies somewhat to the left of the middle line, but as it proceeds downwards it inclines inwards, so that at its termination it is mesial in position. It lies upon the bodies of the vertebræ, and therefore it shows a curve corresponding to that of the vertebral column in the dorsal region. *In front*, it is crossed by the root of the left lung. Below this, it is covered by the pericardium and the posterior part of the diaphragm. *Behind*, it rests upon the vertebral bodies and the intervening intervertebral discs, whilst crossing behind it, the dissector will observe the vena azygos minor inferior,

and, in many cases, the vena azygos minor superior. To *the left side*, and closely applied to the vessel, is that part of the pleura which forms the left lateral wall of the posterior mediastinum; whilst on *its right side* will be noticed the thoracic duct and the vena azygos major (Figs. 177, 180, and 181).

The œsophagus has a varying and important relationship to the thoracic aorta. At first it lies to the *right* of the aorta, but as it approaches the diaphragm it inclines to the left, and comes to lie *in front* of the vessel; and lastly, before it passes through the œsophageal opening of the diaphragm, it is somewhat to its *left side*.

The Branches of the Descending Thoracic Aorta may be grouped under the heads of *visceral* and *parietal*.

Visceral.	Bronchial. Pericardiac. Œsophageal. Posterior mediastinal.
Parietal.	Intercostal (nine on each side).

The *bronchial arteries* are usually three in number—*two* for the left lung and *one* for the right lung. They are very variable in their manner of origin. The *right* bronchial artery often springs from the first aortic intercostal artery. The *left* bronchial arteries generally take origin from the aorta. They run upon the posterior aspect of the corresponding bronchus, and they have already been studied as constituent parts of the roots of the lungs. In the substance of the lung, they follow the bronchi, and show a similar mode of branching and distribution.

The *bronchial veins* are of small size. The *left* opens into the vena azygos minor superior; the *right* joins the vena azygos major.

The *pericardiac branches* are some minute twigs which are distributed to the posterior aspect of the pericardium.

The *œsophageal arteries* are the vessels of supply to the gullet. They are four or five in number, and are irregularly placed. They spring from the front or right side of the

aorta, and form a chain of anastomoses on the wall of the œsophagus. Above, this chain communicates with branches of the inferior thyroid artery, whilst below, it communicates with the ascending œsophageal branches of the coronary artery of the stomach.

The *posterior mediastinal* branches are very small, and are given to the areolar tissue and glands in the posterior mediastinal space.

The *intercostal branches* will be observed arising in pairs from the posterior aspect of the aorta. Defer their examination until the thoracic duct and the sympathetic cords have been dissected.

The Thoracic Duct.—The thoracic duct, although a vessel of small calibre, is one of high importance. It receives all the lymphatic vessels of the body below the diaphragm (except those from part of the upper surface of the liver), the lymphatics of the left side of the chest (including the left lung and left side of the heart), and the lymphatics of the left superior extremity and left side of the head and neck. It will be found by dissecting in the loose areolar tissue which lies between the aorta and the vena azygos major. Its diameter is not much greater than whip-cord, and it will be recognised from its position, and by the great elasticity which it exhibits when it is pulled by the forceps. Trace it downwards, and it will be found to enter the thorax upon the right side of the aorta, and through the same opening in the diaphragm. It commences within the abdomen upon the body of the second lumbar vertebra in a dilatation, called the *receptaculum chyli.* As it is followed upwards it will be noticed to incline gradually to the left. At the level of the fourth dorsal vertebra it passes behind the aortic arch and œsophagus (Fig. 177). It now ascends to the neck between the œsophagus and left pleura, and ends by joining the internal jugular vein at its point of union with the subclavian vein. In the diagrams which are given of the posterior and superior mediastinal spaces, the relations of the thoracic duct

may be studied (Figs. 178, 176, 177, 180, and 181). It will be seen that in the posterior mediastinum it lies behind the œsophagus, but in the superior mediastinum it is placed upon the left side of the œsophagus. In the former situation, before the parts are disturbed by dissection, it can readily be exposed by raising the *right lung* and dividing the right mediastinal pleura; in the latter situation, the *left lung* must be raised and the left mediastinal pleura divided. As it passes upwards through the thorax, the thoracic duct pursues a somewhat wavy or flexuous course. It frequently breaks up into two or more branches, which unite again to form a single trunk. It is provided at intervals with valves of two segments, and these, when the duct is injected, give it a beaded or nodulated appearance. The valves are more especially numerous in the upper part of the duct.

Thoracic Lymphatic Glands.—Throughout the dissection of the thorax the dissector has, from time to time, met with groups of lymphatic glands. These are of considerable importance, seeing that their enlargement in disease is not unfrequently the cause of serious thoracic trouble. The following are the chief groups:—(1.) Two chains of minute glands, which are placed in relation to the anterior thoracic wall and follow the course of the internal mammary vessels. They are termed *sternal glands*, and are joined by lymphatic vessels from the anterior thoracic wall, the mammary glands, the front part of the diaphragm, and the upper part of the front wall of the abdomen. (2.) Two chains of glands on the posterior thoracic wall—one on either side of the spine in relation to the vertebral extremities of the ribs. They are very minute, and offsets from these chains accompany the intercostal vessels between the intercostal muscles. They are therefore called the *intercostal glands*, and they receive the lymphatics of the posterior thoracic wall. (3.) *Anterior mediastinal glands*, two or three in number, and receiving lymphatics from the diaphragm and upper surface of the liver. They occupy the lower open part of the anterior mediastinum. (4.) *Posterior mediastinal glands*, following the course of the thoracic aorta, and joined by lymphatics from the diaphragm, pericardium, and œsophagus. (5.) *Superior mediastinal glands*, an important group, eight to ten in number, and placed in relation to the aortic arch. The lymphatics of the heart, pericardium, and thymus body enter them. (6.) *Bronchial glands*, continuous above with the preceding, and massed chiefly in the interval between the two bronchi.

They are also prolonged into the roots of the lungs. The lymphatic vessels of the lungs pour their contents into them. In the adult, they are generally dark in colour, and sometimes as black as ink.

The lymphatics of the right side of the chest, the right lung, and the right half of the heart join the *right lymphatic duct*, a minute and short vessel situated in the root of the neck. It opens into the angle of union between the right internal jugular and right subclavian veins.

Removal of the Lungs.—The lungs may now be removed by dividing the trachea about an inch and a-half above its bifurcation. The bronchi and vessels should be traced into the lobes of the lungs, and their manner of subdivision and distribution throughout its substance studied.

Ramification of the Bronchi and Vessels within the Lungs.—The student has previously observed that the two lungs are not symmetrical. The right lung is subdivided into three lobes, whilst the left lung is cleft into two lobes. The bronchi exhibit a corresponding want of symmetry. Each tube, as it approaches the pulmonary hilum, divides into branches for the different lobes. The *right bronchus* gives off two such branches for the upper and middle lobes of the right lung respectively, whilst the main stem of the tube sinks into the inferior lobe. The *left bronchus* sends off a large branch to the upper lobe of the left lung, and then enters the lower lobe. The first branch of the right bronchus leaves the main stem about one inch from the trachea. The first branch of the left bronchus, on the other hand, takes origin about twice that distance from the trachea.

But the relation of the pulmonary artery to the bronchial subdivisions is different on the two sides. In both cases it lies in front of the undivided portion of the tube, but on the right side it turns backwards, so as to reach the posterior aspect of the bronchus below the first and above the second division. It is due to this arrangement that the right bronchus occupies the highest level in the right pulmonary root. On the left side, the pulmonary artery turns backwards above the level of the first bronchial branch, and

therefore holds the highest place in the left pulmonary root. On the right side, then, the first bronchial branch is placed above the pulmonary artery, and it is termed the *eparterial bronchus*: all the others lie below it, and are termed *hypar-*

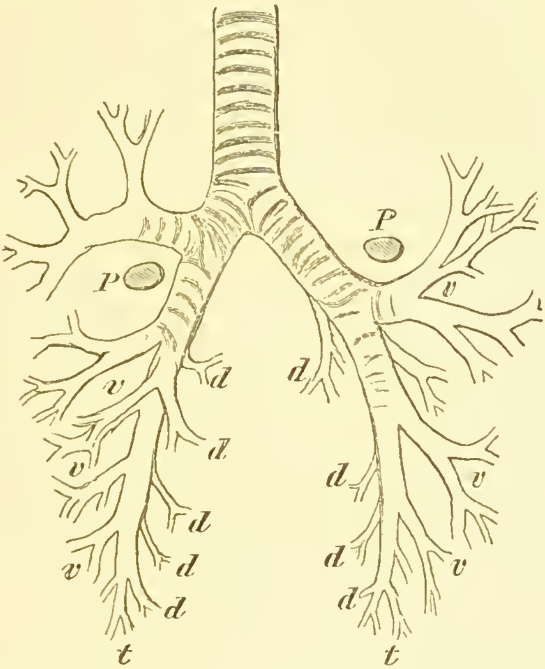

FIG. 183.—Schema of the branching of the two bronchi. (From GEGENBAUR.)

P. Pulmonary artery.
d. Dorsal divisions of the bronchi.
v. Ventral divisions of the bronchi.

The highest *v* on each side indicates the first hyparterial bronchus, or, in other words, the branch to the upper lobe of the left side and the middle lobe on the right side.

terial bronchi. On the left side there is *no eparterial* tube; they are all *hyparterial.*

A consideration of these relations led Aeby to conclude that the eparterial bronchus, and the upper lobe of the right lung to which it goes, are not represented on the left side of the body. In other words, he

believed that the middle lobe of the right lung is the representative of the upper lobe of the left lung.

When the main stem of the bronchus is followed into the inferior lobe on either side, it will be observed to travel downwards towards the back part of the base, and give off, as it proceeds, a series of large *ventral*, and a series of smaller *dorsal* branches. The first hyparterial division on each side (*i.e.*, the branch to the middle lobe of the right side, and the branch to the upper lobe of the left side) may be regarded as the first member of the ventral group (Fig. 183).

It should be observed that when the bronchial tubes enter the lung, they cease to be flattened posteriorly, and become uniformly cylindrical. This is due to the cartilage being disposed around the tube on all its aspects, in the form of irregular flakes, and imperfect rings. The further the tubes are traced, the scarcer and finer become the particles of cartilage.

The *pulmonary vessels* in the substance of the lungs run with the bronchi. The *veins* still keep to the front of the air passages; the *arteries*, however, as we have noted, turn backwards to reach their posterior aspect, and this relation they maintain in the lung substance.

Dissection.—The dissector should next turn his attention to the thoracic portion of the sympathetic nervous system. In order to expose it, he must strip the parietal pleura from the sides of the vertebræ and the inner surface of the ribs.

Gangliated Cord of the Sympathetic.—This extends downwards through the thoracic cavity upon the heads of the ribs and the intervening intercostal spaces, and has an appearance somewhat similar to a knotted string. The thoracic ganglia are usually twelve in number, and, with the exception of the two lowest, they are placed upon the heads of the upper ten ribs. Towards the diaphragm the cord inclines forwards, so that the two lowest ganglia come to lie upon the bodies of the two last dorsal vertebræ. The first

ganglion is considerably larger than those which succeed it. They are all linked together by intervening nervous cords. Superiorly, the thoracic part of the sympathetic is continuous with the cervical sympathetic; whilst inferiorly it becomes continuous with the abdominal portion of the sympathetic by passing behind the ligamentum arcuatum internum of the diaphragm.

The branches which spring from the ganglia may be divided into an *external* and an *internal* series.

The *external series* are branches of communication between the ganglia and the intercostal nerves. Two run between each nerve and the corresponding ganglion. These differ in the kind of fibres which compose them. One is chiefly composed of white cerebro-spinal nerve fibres; the other is mainly formed of grey sympathetic nerve fibres. Through the agency of these two twigs, an interchange of fibres takes place between the intercostal nerve and the sympathetic ganglion.

The *internal series* are branches of distribution. From the *upper five* or *six* ganglia the internal branches go to the thoracic viscera, whilst in the case of the *lower six* ganglia, the internal branches unite to form the splanchnic nerves which are destined for the supply of abdominal viscera. The *thoracic twigs* of supply are very small, and are given to the aorta, to the vertebræ and their ligaments, and to the lungs. The pulmonary branches proceed from the third and fourth ganglia, and they enter the posterior pulmonary plexus. The *splanchnic nerves* are three in number, and are distinguished by the terms *great*, *small*, and *smallest*.

The *great splanchnic nerve* is formed by the union of five roots derived from the sixth, seventh, eighth, ninth, and tenth ganglia. This description, however, must be regarded as being somewhat arbitrary, as there is great variability in the number and manner of origin of the roots of this nerve. It is said that, under certain circumstances, its filaments may be followed upwards upon the sympathetic cord as

high as the third or even the first ganglion. The great splanchnic has more the appearance of a cerebro-spinal nerve than a sympathetic nerve, owing to the large number of spinal nerve fibres which it contains. It passes downwards upon the bodies of the vertebræ, and leaves the thorax by piercing the crus of the diaphragm. Within the abdomen it ends by joining the semilunar ganglion.

Upon the last dorsal vertebra, a ganglion called the *great splanchnic ganglion* will in all probability be found in connection with the great splanchnic nerve. This ganglion is usually of small size, involving only a very few of the anterior fibres of the nerve. Sometimes, however, it forms a distinct oval bulging on the nerve trunk. A few slender filaments are given by the ganglion to the coats of the aorta, and these in some cases may be made out to communicate across the middle line of the body with the corresponding branches of the ganglion of the opposite side.

The *small splanchnic nerve* arises by two roots from the tenth and eleventh thoracic ganglia. It enters the abdomen by piercing the crus of the diaphragm, and it ends by joining the cœliac part of the solar plexus.

The *smallest splanchnic nerve* is a minute twig which takes origin from the twelfth thoracic ganglion. It pierces the diaphragm, and ends in the renal plexus. It is often absent, and then its place is taken by one or more filaments from the small splanchnic nerve.

To obtain a proper view of this minute nerve, the diaphragm should be divided over its course, but this can only be done in cases where the dissector of the abdomen has completed his examination of the diaphragm.

Thoracic Wall.—The thoracic wall should now be studied from within. Certain facts which have previously been stated regarding it can now be verified (*vide* p. 4). The *internal intercostal muscle*, in each space, will be seen to extend backwards as far as the angles of the ribs. At this point it stops abruptly, but the external intercostal muscle is not exposed to view. It is covered on its deep aspect

by the posterior intercostal membrane, the connections of which can now be ascertained.

The *posterior intercostal membrane* is a strong aponeurotic layer which is continuous internally with the outer margin of the superior costo-transverse ligament, and extends outwards upon the deep surface of the external intercostal muscle. At the inner margin of the internal intercostal muscle it passes between the two intercostal muscular strata and is gradually lost. The intercostal vessels and nerve extend outwards upon its anterior aspect under cover of the pleura.

The *subcostal muscles* are also displayed. They are small fleshy fasciculi placed upon the ribs, internal to their angles. The muscular fibres which compose them have the same direction as the internal intercostal muscles. They extend over one or, in many cases, two intercostal spaces.

Dissection.—Remove the posterior intercostal membrane from one or two of the spaces, and the subjacent *external intercostal muscles* will be brought into view. These muscles reach backwards as far as the tubercles of the ribs.

Intercostal Arteries and Nerves.—The *aortic intercostal arteries* have already been seen taking origin from the thoracic aorta. One is given to each of the nine lower intercostal spaces upon both sides of the body. As the aorta lies somewhat to the left of the middle line, the *right* aortic intercostal arteries are longer than those of the left side. In both cases they run outwards over the bodies of the vertebræ, and under cover of the gangliated cord of the sympathetic. On the right side, the arteries also pass under cover of the œsophagus, the thoracic duct, and the vena azygos major. As they leave the vertebral column to enter the intercostal spaces, each of the vessels gives off a large *dorsal branch* which passes backwards in the interval between the transverse processes and is distributed to the muscles and skin of the back. From this branch a *spinal twig* is supplied through the intervertebral foramen

to the spinal cord and its membranes. In each space, the intercostal artery proceeds outwards, first lying between the posterior intercostal membrane and the pleura, and afterwards between the two muscular strata. Each artery is accompanied by a nerve and a vein. The vein usually occupies the *highest* level, the nerve the *lowest* level, whilst the artery is *intermediate.* The distribution of these vessels in the thoracic parietes has already been studied (*vide* p. 7).

The position of the intercostal artery in the intercostal space is a matter of some surgical importance. At first it crosses the intercostal space obliquely, so as to gain the shelter of the subcostal groove of the rib which bounds the space above. It attains this position near the angle of the rib, and as it proceeds forwards the groove affords it a very efficient protection against wounds from without.

The intercostal arteries which supply the *two highest* intercostal spaces, are derived from the *superior intercostal branch* of the subclavian artery. The superior intercostal artery descends upon the necks of the first two ribs, and external to the gangliated cord. It anastomoses with the first aortic intercostal artery, and sends outwards two vessels for the two highest spaces. Each of these, in turn, gives off a *dorsal branch* similar to the dorsal branches of the aortic intercostal arteries.

The *intercostal nerves* pass outwards in company with the arteries. The communicating twigs which pass between these nerves and the sympathetic ganglia have already been noted. Each nerve lies at a lower level than the corresponding artery, and is at first placed between the posterior intercostal membrane and the pleura, and then between the two muscular strata. The further course of these nerves is described at p. 5.

The *first dorsal nerve* will be found passing upwards over the neck of the first rib to join the brachial plexus. It gives a small branch to the first intercostal space, but this

nerve, although it is disposed after the manner of an intercostal nerve, does not furnish, as a rule, a lateral cutaneous branch. The *second dorsal* or *intercostal nerve* very frequently sends a branch upwards over the neck of the second rib, to join that portion of the first dorsal nerve which enters the brachial plexus. As a general rule, this communicating twig is exceedingly minute and insignificant, but sometimes it is a large nerve; and, in these cases, the intercosto-humeral nerve, or lateral cutaneous branch of the second intercostal nerve, is very small or altogether absent.

Veins of the Thoracic Wall.—When the dissector has traced the *intercostal veins* to their various destinations, he will find that they differ in their arrangement upon the two sides of the body. On the *right side* they terminate in three different ways:—

1. The intercostal vein of the first or highest space joins the *right innominate vein* (sometimes the *vertebral vein*).
2. The intercostal veins of the second and third spaces (and sometimes of the fourth space) unite into a common trunk, which joins the upper part of the *vena azygos major*. The common trunk is termed the *superior intercostal vein*.
3. The intercostal veins of the eight lower spaces join the *vena azygos major*.

On the *left side* of the body *four* modes of termination may be recognised:—

1. The intercostal vein of the first or highest space has the same termination as the corresponding vein of the right side. It joins the *left innominate vein* (sometimes the *vertebral vein* of its own side).
2. The intercostal veins of the second and third spaces (and sometimes of the fourth space) converge, and by their union form a single trunk, termed the *superior intercostal vein*, which crosses the arch of the aorta and joins the *left innominate vein* independently of the first intercostal vein (p. 37).
3. The intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces terminate in the *vena azygos minor superior*.
4. The intercostal veins of the ninth, tenth, and eleventh spaces join the *vena azygos minor inferior*.

The azygos veins which thus receive the blood of the great majority of the intercostal veins should now be studied.

Vena Azygos Major (vena azygos).—This vein takes origin within the abdomen in the *ascending lumbar vein* (vena lum-

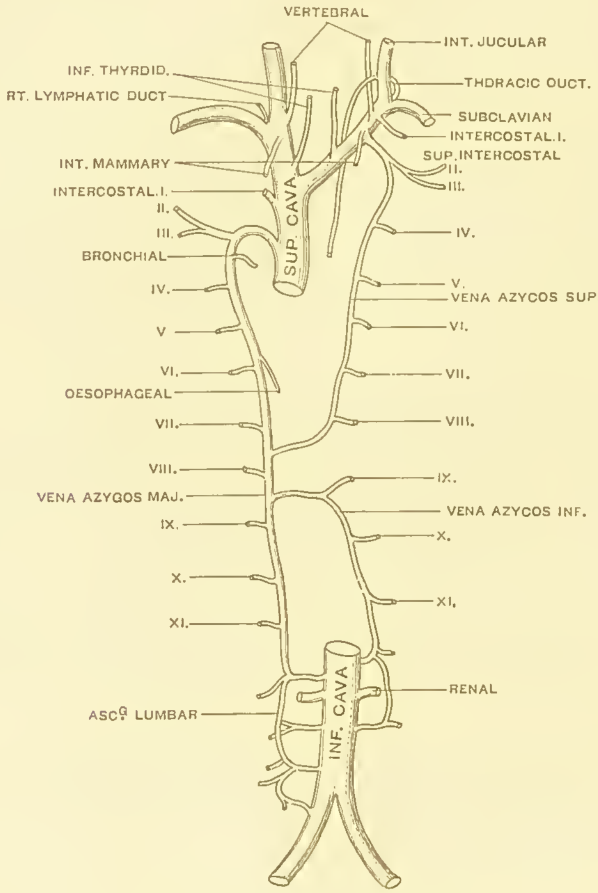

FIG. 184.—Diagram of the azygos and innominate veins.

balis ascendens), a vessel which links together certain of the lumbar veins, and sometimes presents a direct communication with the common iliac vein. It enters the thorax through the aortic opening of the diaphragm, lying upon

the right side of the thoracic duct and the aorta. In the thorax it extends upwards upon the bodies of the dorsal vertebræ and over the right intercostal arteries, until it reaches the level of the upper border of the root of the right lung. At this point it hooks forwards over the right bronchus, and ends by joining the superior vena cava. It is situated in the posterior mediastinum, with the aorta and thoracic duct lying to the left (Figs. 180 and 181).

The *tributaries* of the vena azygos major are as follows: —(1) the superior intercostal vein of the right side; (2) the intercostal veins of the eight lower spaces of the right side; (3) the vena azygos minor superior; (4) the vena azygos minor inferior; (5) the bronchial vein from the right lung; (6) certain of the œsophageal veins; (7) some minute pericardiac veins.

The vena azygos major communicates below with some of the lumbar veins—tributaries of the inferior vena cava; whilst above, it pours its blood into the superior vena cava. In this way it forms a link by which the superior vena cava is brought into connection with the inferior vena cava.

Vena Azygos Minor Superior (vena hemiazygos accessoria).—This vein is formed on the left side of the body by the union of the intercostal veins of the fourth, fifth, sixth, seventh, and eighth spaces. It communicates above with the left superior intercostal vein, which carries the blood from the second and third intercostal spaces to the left innominate vein. At the level of the eighth dorsal vertebra it turns inwards behind the aorta and thoracic duct, and crossing the middle line ends by joining the vena azygos major. In many cases, however, it joins the vena azygos minor inferior. In addition to the intercostal veins it receives the left bronchial vein.

The Vena Azygos Minor Inferior (vena hemiazygos).—This vein takes origin within the abdomen as the left *ascending lumbar vein.* It enters the thorax by piercing the left

crus of the diaphragm, and is continued upwards upon the vertebral column as far as the ninth dorsal vertebra. At this point it turns to the right, and crossing behind the aorta and thoracic duct, it joins the vena azygos major independently of the vena azygos minor superior.

The tributaries of this vein are the intercostal veins of the three lower spaces of the left side.

The veins of the thoracic parietes are extremely variable, and the above description of them must be looked upon as merely representing their more usual arrangement.

THORACIC JOINTS.

The student should now complete the dissection of the thorax by an examination of the various thoracic joints.

Dissection.—The portion of the sternum with the cartilages of the ribs which was laid aside, together with the other joints in connection with the anterior wall of the thorax, should now be dissected. Inter-sternal, costo-sternal, and inter-chondral articulations require examination. Very little dissection is necessary. After the ligaments have been defined, the dissector should remove a thin slice from the anterior aspect of each articulation, in order that the interior of the joint may be displayed.

The Manubrio-gladiolar Articulation between the manubrium and the gladiolus of the sternum partakes of the nature of an amphiarthrosis. The opposing surfaces of bone are covered by a layer of hyaline cartilage, and united by intermediate fibro-cartilage in which a synovial cavity sometimes appears. The joint is supported by some anterior and posterior longitudinal fibres which are developed in connection with the strong and thick periosteum. The posterior ligament is the stronger of the two.

Sterno-costal Articulations.—Seven ribs articulate, by means of their cartilages, directly with each side of the sternum. The articulations of the first and the sixth are

peculiar, inasmuch as they articulate with single pieces of the sternum, viz., with the manubrium and the lowest piece of the gladiolus respectively, whereas the cartilages of the other true ribs each articulates with two segments of the sternum. The cartilage of the first rib is implanted upon the side of the manubrium without any synovial membrane, or other material, intervening. The second costal cartilage is usually separated from the sternum by two synovial membranes, between which an interarticular ligament is developed. In the case of the other joints it is more common to find a single synovial cavity and no interarticular ligament. There is, however, considerable variety in these articulations, and a synovial membrane is very frequently wanting altogether in the costo-sternal joint of the seventh costal cartilage.

With the exception of the first, and very frequently the seventh, the sterno-costal joints belong to the diarthrodial variety. They are provided with anterior and posterior ligaments, and also in those cases where the joint presents a double synovial cavity with an interarticular ligament.

The *anterior* and *posterior ligaments* (ligamenta sterno-costalia radiata) are strong, flattened bands of fibres which radiate from the extremities of the rib-cartilages, and blend with the periosteum on the anterior and posterior surfaces of the sternum. The *interarticular ligaments* are feeble bands which pass from the tips of the rib-cartilages to the sternum, and divide the articulations in which they exist into an upper and a lower compartment, each lined by a synovial membrane.

The Inter-chondral Articulations are joints formed between the adjacent margins of the costal cartilages of some of the lower ribs (generally from the fifth or sixth to the ninth). They are protected by capsules formed by strong oblique ligamentous fibres, and are lined by synovial membranes.

Costo-vertebral Articulations.—With the exception of the first and the last three ribs, the head of each rib arti-

culates with the bodies of two vertebræ and the intervening intervertebral substance (articulatio capituli costæ). The costal head is wedge-shaped, and the socket formed for its reception presents a corresponding form. From the intervertebral disc taking part in the formation of the socket, a certain amount of elasticity is communicated to the joint, and shocks given to the thoracic wall are the more successfully counteracted. The heads of the first, tenth, eleventh, and twelfth ribs are implanted directly upon the bodies of the corresponding vertebræ, although in the case of the first rib the intervertebral disc immediately above also takes a considerable share in the formation of its socket. The articulations between the heads of the ribs and the bodies of the vertebræ are termed the *capitular joints* (articulationes capitulorum).

But the vertebral extremities of the ribs present another series of articulations. The upper ten ribs, by means of their tubercles, rest upon and articulate with the extremities of the transverse processes of the corresponding dorsal vertebræ. These joints are termed the *costo-transverse articulations* (articulationes costo-transversariæ). The eleventh and twelfth ribs have no tubercles, and do not articulate with the transverse processes of the vertebræ with which they are connected.

Capitular Joints.—These joints belong to the diarthrodial variety, and are provided with—(1) an anterior capitular ligament; (2) an interarticular ligament; and (3) two synovial membranes. In the case of the four ribs, however, which articulate with the body of one vertebra alone (viz., the first, tenth, eleventh, and twelfth), the joint cavity is single.

The *anterior capitular* or *stellate ligament* (ligamentum capituli costæ radiatum) is placed in front of the joint. It is composed of strong fibres, which radiate in a fan-shaped manner from the head of the rib. Its vertebral attachment is effected by three, more or less distinct, slips—(1) the

uppermost, which is the largest, passes upwards and inwards to the body of the vertebra, which forms the upper part of the socket for the head of the rib; (2) the middle slip is attached to the intervertebral disc; and (3) the lowest slip goes to the body of the vertebra below the head of the rib. The part of the joint uncovered by the stellate ligament is surrounded by short fibres which form *a capsule*, enclosing the synovial membranes.

In the four joints in which the head of the rib is in contact with the body of one vertebra, the stellate ligament is composed of only two slips. Of these, the *lower* is attached to the body of the vertebra which supports the rib, whilst the *upper* passes upwards to the lower border of the vertebral body immediately above.

Dissection.—The interarticular ligament may be exposed by removing the stellate ligament from the front of the joint.

The *interarticular ligament* of the capitular joints is composed of short strong fibres which are attached, on the one hand, to the ridge between the two articular facets on the head of the rib, and on the other hand to the intervertebral disc. It divides the joint into two synovial cavities, and it is absent in those cases in which the head of the rib articulates with the body of one vertebra.

The *synovial membranes* are two in number, except in the capitular joints of the first and last three ribs. One is placed above, and the other below the interarticular ligament.

The Costo-transverse Articulations are provided with capsular ligaments, and with superior, middle, and posterior costo-transverse ligaments. Each joint cavity is lined by a synovial membrane.

The *superior costo-transverse ligament* (ligamentum costotransversarium anterius) passes obliquely downwards and inwards from the lower border of the transverse process to the upper border of the neck of the rib next below it. Its internal margin is thick and well defined, and its outer border becomes continuous with the posterior intercostal membrane.

The *interosseous costo-transverse ligament* (ligamentum costo-transversarium posterius) consists of fibrous bands which pass between the neck of the rib and the anterior surface of the transverse process against which it rests.

The fibres of this ligament are so short that it is exceedingly difficult to obtain a proper view of them. The best plan is to saw off, in a horizontal direction, the upper parts of the neck of the rib and the transverse process to which it is attached.

The *posterior costo-transverse ligament* (ligamentum tuberculi costæ) is a strong flattened band which passes, on the posterior aspect of the joint, from the tip of the transverse process to the rough portion of the tubercle of the rib.

The posterior costo-transverse ligament, supplemented by a few fibres which surround the synovial membrane of the joint, forms the *capsular ligament*. When the posterior costo-transverse ligament is removed the *synovial membrane* is displayed.

Intervertebral Articulations.—The *bodies* of the vertebræ are held together by a series of amphiarthrodial joints, supported in front by an anterior common ligament, and behind by a posterior common ligament. The *neural arches*, by means of the articular processes, form a series of diarthrodial joints surrounded by capsular ligaments, and lined by synovial membranes. Certain ligaments pass between different portions of the neural arches and their processes, viz., the ligamenta subflava between adjacent laminæ, the inter-transverse, the inter-spinous, and the supra-spinous ligaments.

The laminæ and the spinous processes of the vertebræ have been removed by the dissector of the head and neck in opening up the spinal canal to display the spinal cord. Consequently, the ligamenta subflava, the inter-spinous and supra-spinous ligaments, cannot be seen at present.

The *anterior common ligament* (ligamentum longitudinale anterius) is situated in front of the bodies of the vertebræ, and extends from the axis vertebra above to the first piece of the sacrum below. It consists of stout glistening fibrous bands, which are firmly attached to the margins of the

vertebral bodies and to the intervertebral discs. The most superficial fibres are the longest, and extend from a given vertebra to the fourth or fifth below it. The deeper fibres have a shorter course, and pass between the borders of two, three, or four adjacent vertebræ. The dissector cannot fail to notice that the origin of the longus colli muscle is inseparably connected with this ligament.

The *posterior common ligament* (ligamentum longitudinale posterius) is placed on the back of the vertebral bodies, and therefore within the spinal canal. It is firmly connected to the margins of the vertebral bodies, and to the intervertebral discs, but is separated from the central parts of the bodies by some loose connective tissue and by a plexus of veins. It is constricted where it covers this venous plexus, but widens out opposite the intervertebral discs. It therefore presents a scalloped or denticulated appearance.

The *intervertebral substance* (fibro-cartilago intervertebralis) is disposed between the vertebræ in a series of flattened discs of white fibro-cartilage which correspond in outline to the vertebræ between which they are situated. The peripheral part of each disc is tough and fibrous (annulus fibrosus); the central portion soft and pulpy (nucleus pulposus). In a transverse section the peripheral portion appears concentrically laminated: in a vertical section the most peripheral laminæ are seen to be bent with the convexity turned away from the centre of the disc, the most central laminæ to be bent in the opposite direction, and the intermediate laminæ to be nearly straight. It will be easily seen that this remarkable arrangement increases the elasticity of the spine, and tends to restore it to its natural curvature after it has been deflected by muscular action.

The intervertebral discs constitute the main bond of union between the bodies of the vertebræ, but, except in old people, they are not directly attached to the bone. A thin layer of encrusting hyaline cartilage coats the opposing vertebral surfaces.

Vertical and transverse sections must be made through two or more of the intervertebral discs, in order that their structure may be displayed.

The facets of the *articular processes* are coated by hyaline cartilage. A capsular ligament lined by a synovial membrane encloses each joint.

The *intertransverse ligaments* are feeble bands which pass between the tips of the transverse processes. In the lower part of the dorsal region they are intimately blended with the intertransverse muscles: in the middle and upper parts of the dorsal region they entirely replace the muscles.

HEAD AND NECK.

The dissector of the Head and Neck begins work on the same day that the subject is brought into the Dissecting-room. It is placed on a short table for this purpose, and of the two days during which it remains in the lithotomy position, the *first* should be devoted to the dissection of the scalp, and the *second* to the removal of the brain.

SCALP.

Strictly speaking, the term "scalp" should be restricted to the soft parts which cover the vault of the cranium above the level of the temporal ridges and the superior curved line of the occipital bone, but it is convenient to dissect at the same time the superficial structures in the temporal regions.

Above the level of the temporal ridges we meet with five strata as we dissect from the surface to the bone, viz.—(1) the skin; (2) the superficial fascia; (3) the occipito-frontalis muscle, with its extensive epicranial aponeurosis;

(4) a layer of loose areolar tissue; and (5) the periosteum, which is here termed the pericranium.

Below the level of the temporal ridges additional structures are observed coating the cranium. As many as eight layers may be recognised, viz.—(1) skin; (2) superficial fascia; (3) the small extrinsic muscles of the ear; (4) the thin lateral part of the epicranial aponeurosis; (5) a thin layer of fascia descending from the temporal ridge to the pinna; (6) the temporal fascia; (7) the temporal muscle; (8) the periosteum.

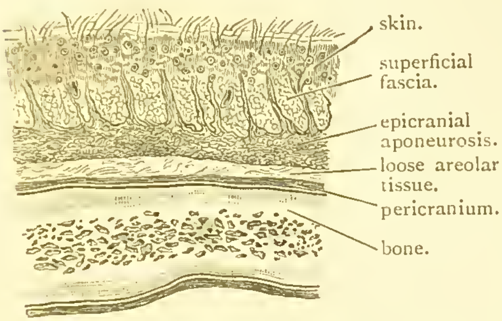

FIG. 185.—Section through the scalp and cranial wall. (Modified from MERKEL.)

The scalp is richly supplied with both nerves and blood vessels.

Dissection.—The dissector should place a block under the head so as to raise it to a convenient height, and proceed with the dissection.

Three incisions through the skin are required, viz.—(1) from the root of the nose along the middle line of the cranium, to a point a little beyond the external occipital protuberance; (2) from the tip of the mastoid process on one side, over the summit of the head to a corresponding point upon the opposite side; (3) from the point where the latter incision reaches the pinna downwards in front of the auricle to the root of the zygoma. Four flaps of skin are thus marked out, and these should be carefully raised from the subjacent superficial fascia. This, however, is no easy matter, owing to the very firm connection which exists between them. The roots of the hair which pierce the integument obliquely, and are embedded in the superficial fascia, add another difficulty to the proper reflection of the integument.

Superficial Fascia.—On the summit of the cranium the superficial fascia, although thin, is exceedingly dense and tough, owing to strong septa of fibrous tissue which bind it

on the one hand to the integument, and on the other to the subjacent epicranial aponeurosis. The meshes formed by these fibrous processes are filled with small lobules of fat, which give this layer a granular appearance. As the fascia is traced forwards towards the forehead, and downwards on each side towards the ears, it loses in great part its dense fibrous character, and becomes looser and less fatty. It is in the superficial fascia that the cutaneous vessels and nerves ramify before they enter the skin.

Dissection.—The superficial fascia may now be removed from the surface of the occipito-frontalis. In doing this, the dissector must proceed very cautiously, so as not to injure the cutaneous nerves and blood vessels which ramify in its midst. It is impossible, owing to its density, to raise it in one layer ; it must be taken away piecemeal.

The Occipito-frontalis (epicranius) is a quadricipital muscle possessing two occipital and two frontal bellies. The *occipital bellies* (musculi occipitales)—Fig. 186 (2)—are quite distinct from each other, and are separated by a marked interval. Each arises from the outer two-thirds of the superior curved line of the occipital bone, and from a small portion of the adjoining part of the mastoid process of the temporal bone immediately above the insertion of the sterno-mastoid. From this the fibres ascend for a distance of about two inches in the form of a thin, dark-red, fleshy layer, which is inserted into the epicranial aponeurosis.

The *frontal bellies* (musculi frontales) are composed of pale fibres, and are not perfectly distinct from each other. For a short distance above the root of the nose their inner margins are blended along the middle line. Above this, however, they diverge slightly, and are separated by a narrow interval. They possess little or no direct attachment to bone. The greater number of the fibres mingle with those of the orbicularis palpebrarum and the corrugator supercilii muscles, and gain an attachment to the integument and subcutaneous tissue over the eyebrow, whilst a few of the innermost fibres

proceed downwards upon the nasal bone to form the pyramidalis nasi muscle. Ascending upon the forehead, the frontal bellies are inserted near the line of the coronal suture into the epicranial aponeurosis.

The Epicranial Aponeurosis (*galea aponeurotica*) which connects the occipital and frontal bellies of the occipito-frontalis muscle, constitutes a continuous layer over the summit and sides of the head. Posteriorly it can be traced backwards in the interval between the two occipital bellies of the muscle, when it will be observed to have an attachment to the external occipital protuberance and the superior curved line of the occipital bone. Laterally, it presents no sharply defined margin, but, losing its aponeurotic character, it is prolonged downwards as a fine expansion over the temporal fascia. In this locality it gives origin to two of the small auricular muscles.

Dissection.—Divide the epicranial aponeurosis by a mesial incision of about an inch and a-half in length, and then carry across the middle of this a second short transverse cut. On raising the corners thus marked out, the aponeurosis will be seen to rest upon a layer of loose flocculent areolar tissue, containing no fat—the *fourth stratum* of the scalp. Owing to the great laxity of this tissue, the occipito-frontalis muscle by its contractions can move the hairy scalp freely over the pericranium which invests the bone.

Extrinsic Muscles of the Ear.—In man these muscles are very poorly developed, and the auricle possesses in consequence only a very limited power of independent movement. They are three in number, viz. :—

1. Attollens auriculam.
2. Attrahens auriculam.
3. Retrahens auriculam.

The first two of these are so thin that it requires an experienced and careful dissector to isolate them from the superficial fascia.

Attollens auriculam—Fig. 186 (1).—To expose this muscle the upper part of the auricle must be dragged downwards,

and then fixed in this position by means of a hook. The muscular fibres are thus rendered tense and stand out in relief. When cleaned it will be seen to be a fan-shaped muscle, placed immediately above the ear. Above, it is broad, and arises from the epicranial aponeurosis where it covers the temporal fascia; below, the fibres converge as they approach the auricle and gain an insertion into the upper part of the cranial surface of the pinna.

The *attrahens auriculam*, which is smaller than the preceding, is placed in front of the ear, and the auricle must therefore be pulled backwards in order that its fibres may be rendered tense. It arises from the epicranial aponeurosis, and it is inserted into the anterior aspect of the helix of the pinna.

The *retrahens auriculam*—Fig. 186 (3)—consists of two or three short bundles of muscular fibres which spring from the mastoid process of the temporal bone, and are inserted into the posterior part of the concha. It is readily exposed by drawing the ear forwards.

The *attrahens auriculam* is supplied by a twig from the temporal branches of the facial nerve; the *retrahens* and *attollens* by the posterior auricular branch of the facial nerve.

Nerves of the Scalp.—Two nerves are given to the *frontal* and *parietal* portions of the scalp by the frontal branch of the ophthalmic division of the trigeminal nerve. These are (*a*) the supra-trochlear, (*b*) the supra-orbital.

The *supra-trochlear nerve* leaves the orbit close to its inner angle and then turns upwards under cover of the orbicularis palpebrarum. Immediately beyond this muscle it becomes superficial by piercing the frontal portion of the occipito-frontalis, and, after a short course in the superficial fascia, it ends in the integument of the forehead.

The *supra-orbital nerve* is much larger than the preceding, and quits the orbit by turning upwards in the supra-orbital notch. The position of this notch in the superior margin of the orbit can generally be detected by the finger. The

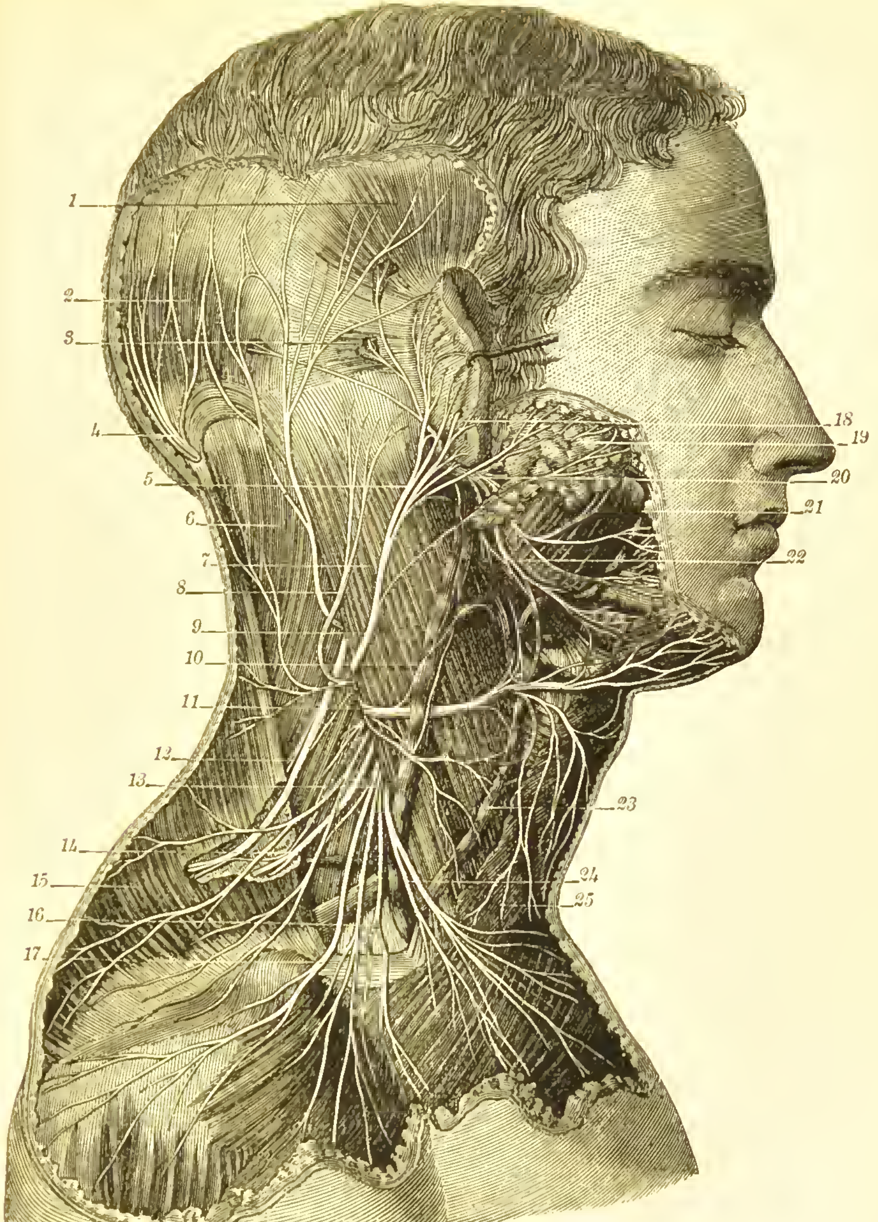

FIG. 186.—Superficial nerves on the side of the neck and back of the scalp.—(HIRSCHFELD and LEVEILLÉ).

1. Attollens auriculam
2. Posterior belly of occipito-frontalis
3. Retrahens auriculam
4. Great occipital nerve
5. Great auricular nerve
6. Splenius muscle
7. Sterno-mastoid muscle
8. Small occipital nerve (present as two branches)
9. Great auricular nerve
10. External jugular vein
11. Superficial cervical nerve
12. Spinal accessory nerve
13. Descending branches of cervical plexus
14. Cervical branches to trapezius
15. Trapezius muscle
16. Supra-clavicular branches
17. Supra-acromial branches
18. Auricular twigs of great auricular nerve
19. Parotid gland
20. Facial nerve
21. Masseter muscle
22. Infra-mandibular nerve
23. Anterior jugular vein
24. Supra-sternal branches
25. Platysma myoides

nerve now ascends under cover of the orbicularis palpebrarum and the frontal belly of the occipito-frontalis, and divides into an inner and an outer division. There is a slight difference in the manner in which these reach the surface. The *inner division* becomes superficial by piercing the anterior belly of the occipito-frontalis, whilst the *outer division* comes to the surface a little further back by piercing the epicranial aponeurosis. Both ramify in the superficial fascia over the parietal bone, and give numerous twigs to the skin. The outer division can be traced as far back as the lambdoidal suture.

In the *temporal region*, nerves from three sources are to be found,—(*a*) from the facial nerve; (*b*) from the orbital branch of the superior maxillary division of the trigeminal nerve; (*c*) from the auriculo-temporal branch of the inferior maxillary division of the trigeminal nerve.

The *temporal branches of the facial nerve* will be noticed running upwards over the zygoma. They furnish twigs of supply to the attrahens auriculam, frontal belly of the occipito-frontalis, orbicularis palpebrarum, and corrugator supercilii.

The *temporal branch of the orbital nerve* is a minute twig, which is somewhat difficult to find. If the finger be carried downwards from the external angular process of the frontal bone along the posterior margin of the malar bone, a tubercle on the latter will be felt. This is the guide to the temporal branch of the orbital nerve; it pierces the temporal fascia immediately behind it. It therefore makes its appearance about one inch above the anterior part of the zygoma, and the dissector is frequently led to it by a communicating twig from one of the facial branches. It is distributed to a limited area of skin in this region.

The *auriculo-temporal nerve* will be found immediately in front of the ear, in close contact with the superficial temporal artery. It soon divides into two branches, which diverge from each other as they ascend, and a careful dissector may

be able to trace twigs from these as far as the summit of the head. Its branches terminate in the skin of the scalp.

In the *mastoid* and *occipital regions* of the scalp, the dissector will meet with *four* nerves, each from a different source; (*a*) the posterior auricular branch of the facial nerve —Fig. 186 (3); (*b*) the mastoid branch of the great auricular nerve; (*c*) the small occipital nerve from the anterior primary division of the second cervical nerve—Fig. 186 (8); and (*d*) the great occipital nerve from the posterior primary division of the second cervical nerve—Fig. 186 (4).

The *posterior auricular* is a small nerve which ascends upon the front of the mastoid process, immediately behind the ear. The guide to it is the posterior auricular artery, which lies in contact with it. After effecting a communication with the great auricular nerve, it divides into an auricular and an occipital division. The *auricular division* continues its upward course, and ends by supplying the retrahens auriculam and attollens auriculam muscles; the *occipital division* inclines backwards along the superior curved line of the occipital bone, and ends in the occipital belly of the occipito-frontalis muscle.

In searching for the posterior auricular nerve, the dissector will, in all probability, meet with the *mastoid branch* of the great auricular nerve, which ascends upon the mastoid process on a more superficial plane.

The *small occipital nerve* will be discovered midway between the ear and the external occipital protuberance. It supplies numerous branches to the integument, and furnishes an *auricular twig* to the skin over the upper part of the cranial aspect of the ear. It communicates with the great auricular nerve on the one hand, and with the great occipital nerve on the other.

The *great occipital* is a large nerve, and there will be little difficulty experienced in finding it, as it lies close to the occipital artery, a short distance external to the occipital

protuberance. Its branches spread out over the back of the head, and supply a wide area of integument. It sends an *auricular twig* to the skin over the cranial aspect of the ear, and communicates with the small occipital nerve.

Blood Vessels of the Scalp.—Two small arteries—viz., the *frontal* and the *supra-orbital*, both branches of the ophthalmic, leave the orbit to supply the forehead. The former is associated with the supra-trochlear nerve, and the latter with the supra-orbital nerve. The *veins* corresponding to these arteries unite at the inner margin of the orbit to form the *angular vein*, which afterwards becomes the facial vein.

The *superficial temporary artery* will be noticed ascending upon the temporal fascia, immediately in front of the ear. At a variable point above the zygoma it divides into its two terminal branches—viz., the anterior and posterior superficial temporal arteries.

The *anterior superficial temporal artery* takes a tortuous course upwards and forwards to the forehead, and supplies numerous branches to the integument, muscles, and pericranium. Further, it anastomoses with the frontal and supra-orbital arteries, and with the corresponding vessel of the opposite side.

The *posterior superficial temporal artery* inclines upwards and backwards, arching over the cranium above the auricle. It gives off numerous twigs to the parts in this region, and communicates with its fellow of the opposite side, and with the posterior auricular and occipital arteries.

The *posterior auricular artery* ascends in the angle between the cartilage of the ear and the mastoid process, and ends by dividing into two branches, named respectively the auricular and the mastoid. The *auricular branch* ascends under cover of the retrahens auriculam muscle, and supplies several twigs to the pinna, and, finally turning forwards above the auricle, it anastomoses with the posterior superficial temporal artery. The *mastoid branch* inclines

backwards towards the occiput, where it communicates with the occipital artery.

The *posterior auricular vein* is a comparatively large vessel. It joins the posterior division of the temporo-maxillary vein, near the angle of the lower jaw, to form the external jugular vein.

The *occipital artery*, which will be found a short distance to the outer side of the occipital protuberance, sends large tortuous branches over the back of the head. These anastomose with the corresponding vessels of the opposite side, and with the posterior auricular and posterior temporal arteries.

Temporal Fascia.—If the epicranial aponeurosis with the attached auricular muscles be now raised in the temporal region, a thin but distinct sheet of fascia will be observed proceeding from the upper temporal line of the parietal bone, in close relation to the deep surface of the attollens auriculam, to the pinna. When this is removed the strong temporal fascia which covers the temporal muscle is brought fully into view. Its connections will be studied at a later period.

Surgical Anatomy of the Scalp.—The close connection between the three superficial layers of the scalp (viz., skin, superficial fascia, and epicranial aponeurosis), and the loose manner in which these are bound by areolar tissue to the pericranium, are points of great interest from a surgical point of view. When the scalp is wrenched from the head by machinery, or by any other means, the separation is effected in the plane of the areolar layer. The blood vessels, however, lie for the most part in the superficial fascia, and therefore large flaps of detached scalp can be replaced upon the denuded periosteum, and yet retain their vitality. It is a rare occurrence for a scalp flap to slough.

The scalp is richly supplied with blood vessels. Incised wounds in this region, therefore, bleed very profusely ; but, in addition to this, they bleed with more than usual persistence. This is accounted for by the dense character of the superficial fascia, and by the fact that the fibrous septa of this stratum adhere to the coats of the vessels, and prevent them from retracting freely when divided.

As will readily be understood, a collection of pus in the scalp will

produce very different results, according to the position it occupies. If it is formed under the epicranial aponeurosis it spreads in all directions ; indeed, it is only limited in front by the superciliary ridges of the frontal bone, and behind by the superior curved line of the occipital bone. If it is formed in the superficial fascia, it is confined to the point at which it originates.

REMOVAL OF THE BRAIN.

On the second day after the subject has been placed on the table, the two dissectors of the head and neck should, in conjunction with each other, proceed to remove the brain.

Dissection.—The head being supported upon a block, an incision is made along the middle line of the head, through the epicranium, the subjacent areolar tissue, and the pericranium, from the root of the nose in front, to the external occipital protuberance behind. This must be done boldly, so as to divide everything right down to the bone. With a series of sharp strokes with the handle of the scalpel, the pericranium on each side can easily be turned outwards, so as to leave the bone perfectly bare. Observe, however, that although the pericranium is loosely attached over the surface of the various bones of the vault, that it is firmly attached along the lines of the cranial sutures by processes that dip in between the bones, so as to separate their edges. On reaching the temporal ridges, push the knife through the attachment of the temporal fascia, so that the blade lies between the temporal muscle and the bone. Then run the knife backwards and forwards, so as to thoroughly divide the attachment of the fascia to the ridge. When this is done on either side, the fascia and muscle can be easily raised together from the temporal fossa, and thrown down over the ear with the remains of the scalp.

The dissectors should next obtain a saw, a chisel, and a mallet, and proceed to remove the calvaria. The line along which the saw is to be used may be marked out on the skull by encircling it with a piece of string, and then marking the cranium with a pencil along the line of the string. In front the cut should be made fully three-quarters of an inch above the margins of the orbits, behind it should be carried round at the level of a point midway between the lambda[1] and the external occipital protuberance. The saw should only

[1] The term " lambda " signifies the apex of the occipital bone, or the point at which the sagittal and lambdoidal sutures meet.

be used to divide the outer table of the skull. When the diploe is reached, which will be observed by the sawdust becoming red and moist, the saw should be abandoned. The hammer and chisel are now brought into requisition, and by these the inner table can readily be split along the line in which the outer table of the cranium is divided. By insinuating the hook at the end of the cross-bar of the chisel into the fissure in front, the skull-cap can be forcibly wrenched off.

Dura Mater.—The brain is clothed by three distinct membranes, which are termed the *meninges*. These are

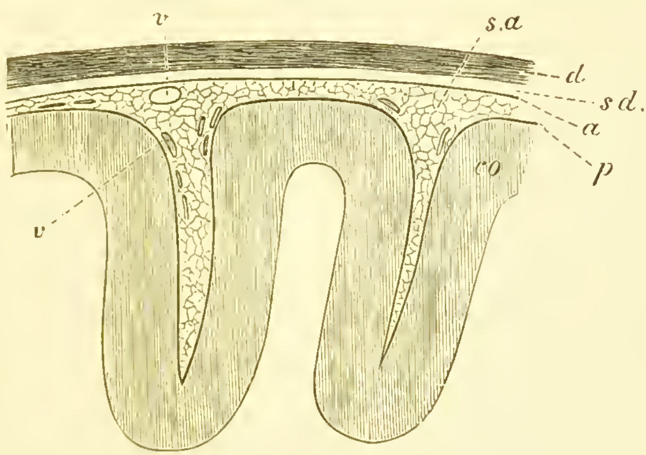

FIG. 187.—Diagrammatic section through the meninges of the brain. (SCHWALBE.)

d. Dura mater.
sd. Subdural space.
a. Arachnoid mater.
sa. Sub-arachnoid space and trabeculæ.
v. Veins.
p. Pia mater.
co. Grey matter of cerebral convolutions.

from without inwards—(1) the dura mater; (2) the arachnoid mater; and (3) the pia mater.

When the skull-cap is detached, the outer surface of the dura mater, as it covers the upper surface of the cerebral hemispheres, is exposed. It is rough, and dotted over with bleeding points. If a portion were placed in water, its roughness would become still more manifest, and be seen to be due to a multitude of fine fibrous and vascular processes, by which

it is connected with the deep surface of the bones. These have necessarily been torn asunder in the removal of the skull-cap. The bleeding points are most numerous along the middle line, or, in other words, along the line of the superior longitudinal sinus; and if the handle of the knife be run from before backwards, so as to make pressure along this line, a considerable quantity of blood will ooze out. This shows that a number of small veins from the cranial bones have been ruptured. The degree of adhesion between the dura mater and the inner surface of the cranial bones varies in different subjects and in different localities. In all cases it is most adherent along the lines of the sutures; and, further, it is very much more firmly attached to the base than the vault of the cranium. In the child—indeed, as long as the bones of the cranium are growing—it is more adherent than in the adult; and it is also more firmly bound to the bone in old age.

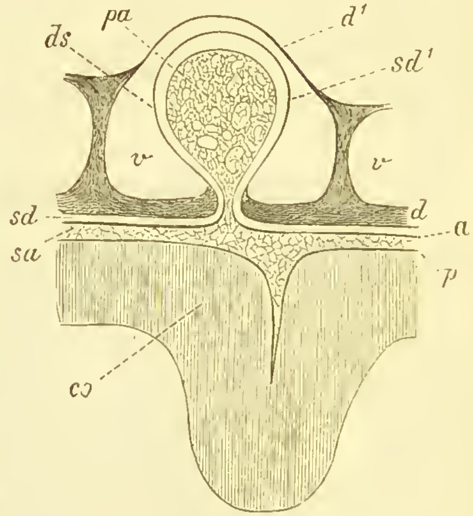

FIG. 188.—Diagrammatic section through an arachnoidal villus. (SCHWALBE.)

pa. Villus (Pacchionian body).
d. Dura mater (deep layer).
d'. Superficial layer of dura mater.
ds. Deep layer of dura around villus.
v. Lacuna lateralis or parasinoidal sinus into which the villus projects.
sd. Subdural space.
sd'. Subdural space around villus.
a. Arachnoid mater.
sa. Sub-arachnoid space and trabeculæ.
p. Pia mater.
co. Convolution of cerebrum.

The dissector should now wipe the outer surface of the dura mater with a sponge. He will then recognise the

middle meningeal artery upon each side, ascending in the substance of the membrane, and sending off its branches in a widely-arborescent manner. It stands out in bold relief from the membrane in which it ramifies ; and if the skull-cap be examined, its inner surface will be observed to be deeply grooved by its ramifications. The meningeal arteries, as the name might lead one to imagine, are not intended for the supply of the membrane alone. They also must be looked upon as the nutrient vessels of the inner table and diploe of the cranial bones.

The *Pacchionian bodies* or *arachnoidal villi*, which are almost invariably present, and which are as a rule best marked in old subjects, will attract notice at this stage. They are small granular bodies, ranged in clusters on either side of the superior longitudinal sinus, into which they not unfrequently protrude (Fig. 189). As a general rule, they are most evident towards the hinder part of the parietal region. At first sight these bodies appear to be protrusions from the dura mater, but this is not the case. They spring from the arachnoid mater, and are enlargements of the normal villi of this membrane.

The relation which the Pacchionian bodies present to the dura mater is somewhat intricate. When they project into the superior longitudinal sinus they push before them a thin covering continuous with the floor of the sinus, so that in no sense can they be said to pierce its wall. On either side of the superior longitudinal sinus there are a number of irregular spaces or intervals which communicate with the sinus either by a small aperture or a narrow channel. These recesses are termed *parasinoidal sinuses* or *lacunæ laterales*, and the independent meningeal veins, and some of the diploic veins, pour their blood into them. Pacchionian bodies push themselves into the parasinoidal sinuses from below in such a manner that they receive a complete covering by the invagination of the floor. Nor does the bone escape. As the Pacchionian bodies enlarge, they cause absorption of the cranial wall, and small pits are hollowed out on its deep surface for their reception. The superficial walls of the lacunæ—very much thinned—line these depressions in the calvaria.

Two Layers of the Dura Mater.—Having learned these preliminary details from an examination of the outer

surface of the dura mater, as it clothes the upper surface of the cerebral hemispheres, the student is in a position to understand that this membrane does not belong entirely to the brain. It performs a double function ; (1) it acts as an internal periosteum to the bones forming the cranial cavity ; and (2) it gives support to the different parts of the brain. Consequently, it consists of two strata, which, in most localities, are firmly adherent, but which nevertheless can usually be easily demonstrated in the dissecting room. These strata may very appropriately be termed the *endocranial* and the *supporting layers.* Along certain lines these two layers separate from each other, and for two distinct purposes. In some cases they separate for the purpose of forming channels, termed *blood sinuses,* for the conveyance of venous blood ; in other cases they separate in order that the inner supporting layer may form strong folds or partitions, which run in between the various parts of the brain. By these latter the cranial cavity is divided into compartments communicating freely with each other, and each holding a corresponding subdivision of the brain (Fig. 191).

Dissection.—These points must now be verified. Begin by tilting the head forwards. Support it in this position, and make two incisions through the dura mater in an antero-posterior direction—one on each side of the superior longitudinal sinus, and along its whole length. From the mid-point of each of these incisions another cut must be made through each lateral portion of the dura mater downwards to the cut margin of the skull immediately above the ear (Fig. 189). The dura mater covering the upper aspect of the brain is thus divided into a central strip containing the superior longitudinal sinus and four triangular flaps. The flaps should now be turned downwards over the cut margin of the skull, and in this position they preserve the brain during its removal from laceration by the sharp bony edge.

The Subdural Space is now opened into. This is the term which is applied to the interval between the dura mater and the arachnoid mater—Fig. 187 (*sd*), p. 113. It contains a very small quantity of serous fluid which moistens the opposed surfaces of these membranes. A striking

contrast between the two surfaces of the dura mater will be observed. The superficial surface, as we have noted, is rough and flocculent. The deep surface, which is turned towards the subdural space, is smooth, polished, and glistening.

The Cerebral Veins returning the blood from the surface of the cerebral hemispheres will be seen shining through the arachnoid. They are lodged in the sulci

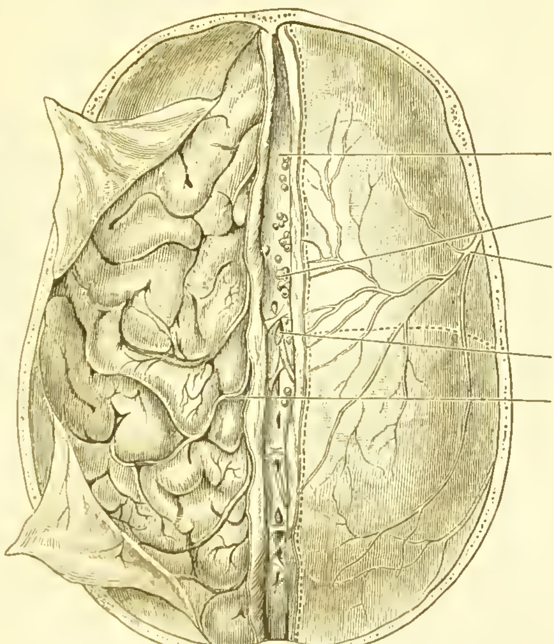

FIG. 189.—The dura mater and the superior longitudinal sinus, &c. The lines along which the dura mater should be incised in removing the brain are indicated by dotted lines on the right side.

between the convolutions, and run upwards to the middle line. Reaching the superior longitudinal sinus they are suddenly directed forwards, and lie against the wall of the sinus for some distance before they open into it (Fig. 189).

Superior Longitudinal Sinus (sinus sagittalis superior). —Open into this venous channel by running the knife

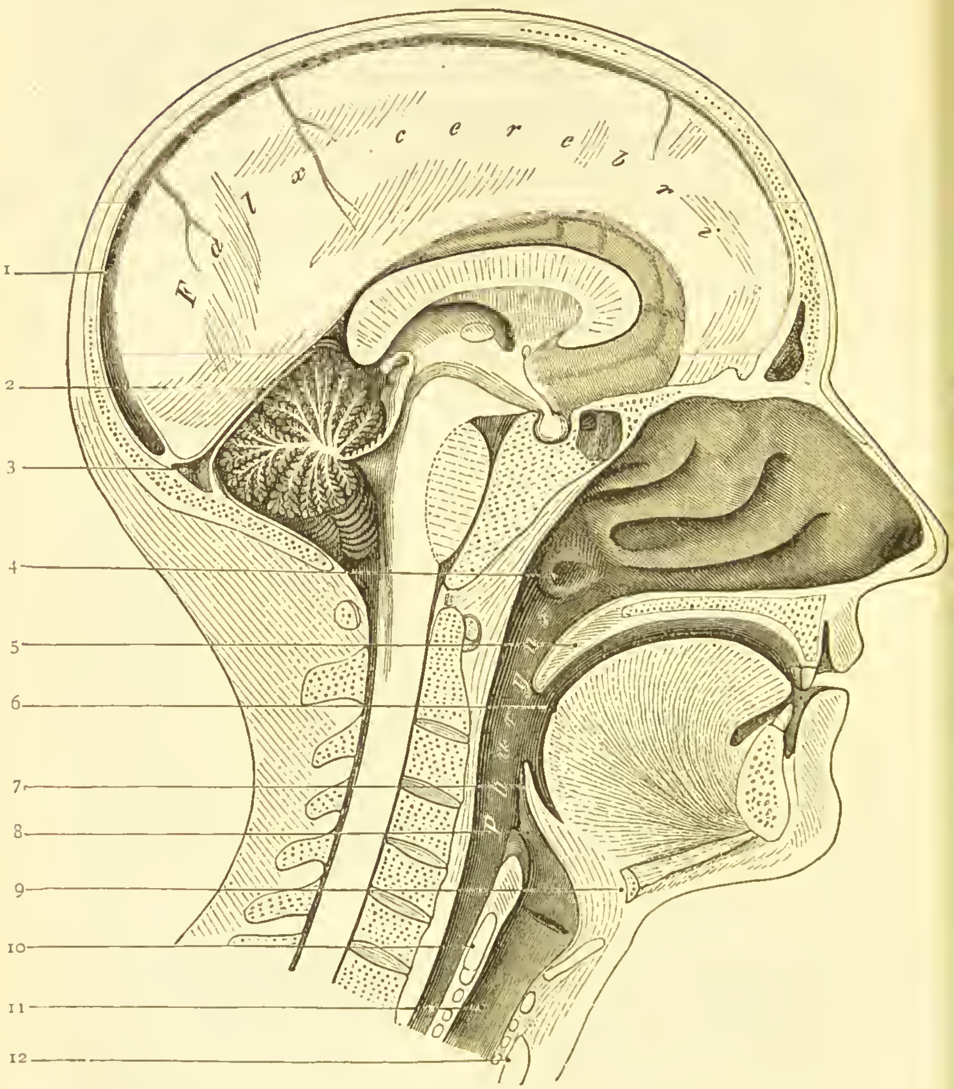

FIG. 190.—Mesial section of the head. (From GEGENBAUR.)

1. Superior longitudinal sinus.
2. Straight sinus.
3. Torcular Herophili.
4. Eustachian tube.
5. Soft palate.
6. Buccal cavity.
7. Epiglottis.
8. Opening of the larynx.
9. Hyoid bone.
10. Cricoid cartilage.
11. Trachea.
12. Isthmus of thyroid body.

through its upper wall from behind forwards (Fig. 189). It begins in front at the crista galli of the ethmoid bone, where it not unfrequently communicates with the veins in the nasal cavity through the foramen cæcum, and it extends backwards, grooving the cranial vault in the middle line, to the internal occipital protuberance (Figs. 190 and 192). Its lumen, which is triangular in form, is very small in front, but expands greatly as it is followed backwards.

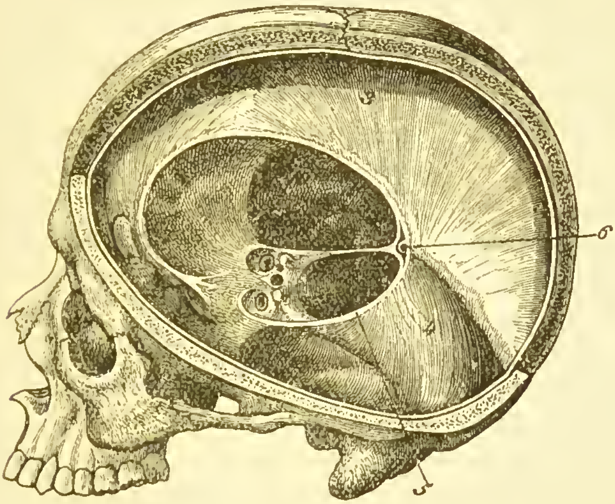

FIG. 191.—The dura mater. (LUSCHKA.)

2. The oval aperture between anterior border of tentorium and dorsum sellæ.
3. Falx cerebri.
4. Tentorium.
5. Anterior concave margin of tentorium.
6. Vein of Galen entering the straight sinus.

The mouths of the superior cerebral veins are observed opening into it (Fig. 189). These veins pour their blood into it in a direction contrary to that in which the blood flows within the channel. The terminal portions of the veins are directed from behind forwards, whilst the blood in the sinus flows from before backwards. The channel is crossed at its inferior angle by a number of minute bands. These receive the name of *chordæ Willisii.*

Falx Cerebri—Figs. 190, 191, and 192.—This is a sickle-shaped reduplication of the supporting layer of the dura mater, which descends in the mesial plane between the two cerebral hemispheres. In order to expose it, the cerebral veins, as they open into the superior longitudinal sinus, must be divided, and the hemisphere gently pulled outwards. In front, the falx cerebri is narrow, and attached to the crista galli of the ethmoid bone. As it is followed backwards, it increases in breadth, and behind, it is attached in the middle line to the upper surface of the tentorium cerebelli, its two lamellæ separating along the line of junction so as to form with the tentorium a blood sinus, termed the *straight sinus* (sinus rectus)—Fig. 192 (6), p. 125. Along its superior convex border its two layers separate and form, with the endocranial layer of the dura mater, the *superior longitudinal sinus*—Fig. 192 (5), p. 125. Its inferior concave margin is free, and overhangs the corpus callosum, with which, however, it is not in contact, except, perhaps, very slightly behind. Running backwards in this margin is the *inferior longitudinal sinus* (sinus sagittalis inferior).

Removal of the Brain.—The dissectors should now proceed to remove the brain. Having divided the attachment of the falx cerebri to the crista galli, pull it backwards. Next, removing the block upon which the head rests, and supporting the occiput and posterior lobes of the brain with the left hand, let the head drop well backwards. In all probability, the frontal lobes will fall away by their own weight from the anterior fossa of the base of the cranium, and perhaps carry with them the olfactory bulbs. Should they remain in position, however, gently raise them with the fingers, and separate, at the same time, with the handle of the knife the olfactory bulbs from the cribriform plate of the ethmoid. In raising the olfactory bulbs, the minute *olfactory nerves* which spring from them and perforate the cribriform plate of the ethmoid bone are torn across. The large round and white *optic nerves* (second pair of cranial

nerves) now come into view as they leave the cranium through the optic foramina. When these are divided, the *internal carotid arteries* will be exposed, and between them, in the mesial plane, the *infundibulum*, a hollow conical process which connects the pituitary body with the tuber cinereum—a lamina of grey matter on the base of the brain. It will be noticed that the infundibulum lies slightly behind the internal carotid arteries.[1] Sever in turn each of these structures. We then come upon the *oculo-motor nerves* (third pair of cranial nerves), which must be dealt with in like manner. Observe first, however, that they lie behind, and external to the carotid trunks. The dissector should now see upon either side the anterior extremity of the inner free margin of the tentorium cerebelli as it passes forward to be attached to the anterior clinoid process. Pressing this outwards with the point of the knife, the minute *trochlear nerve* (fourth cranial nerve) will be brought into view. It lies under shelter of the free border of the tentorium, and should be divided at this stage. The head must in the next place be turned forcibly round, so that the face is directed over the left shoulder. On raising the posterior part of the right cerebral hemisphere with the fingers, it will be observed to rest upon the tentorium cerebelli—a broad horizontal process of dura mater, which intervenes between it and the cerebellum. Divide the tentorium along its attached border, and take care in doing this not to injure the subjacent cerebellum. When the division is effected, push the tentorium backwards out of the way with the point of the knife. Now turn the head so as to bring its left side uppermost, and treat the tentorium on this side in the same manner. The two parts of the *trigeminal nerve* (fifth cranial nerve) perforating the dura mater near the apex of the petrous portion of the temporal bone; the *abducent nerve* (sixth cranial nerve) pierc-

[1] In dividing the cranial nerves, it is well to cut them close to the point where they pierce the dura mater on one side of the body, and close to the brain on the other side.

ing the dura mater behind the dorsum sellæ of the sphenoid bone; the *portio dura* or *facial nerve*, the *pars intermedia*, and the *portio mollis* or *auditory nerve*, disappearing into the internal auditory meatus; the *glosso-pharyngeal*, the *vagus*, and the *spinal accessory nerves* leaving the skull through the jugular foramen; and the two slips of the *hypoglossal nerve* piercing the dura mater over the anterior condyloid foramen, will each in turn come into view upon either side, and each must be divided in succession. In the case of the three nerves passing out of the cranium through the jugular foramen, the dissector should endeavour to leave the spinal accessory of the right side intact within the cranium, by dividing its roots of origin from the medulla, whilst on the other side he removes it with the brain. This nerve will be readily recognised from its ascending from the spinal canal into the cranial cavity through the foramen magnum. It is only necessary now for the dissector to thrust the knife into the spinal canal, and divide the vertebral arteries as they turn forwards upon the upper part of the spinal cord, and then sever at a lower level the spinal cord, the spinal accessory nerve of the left side, and the roots of the first pair of spinal nerves. By letting the head fall well backwards, and gently dislodging the medulla and cerebellum, the whole brain can be removed. The veins of Galen, as they pass from the interior of the brain to enter the straight sinus, are ruptured by this proceeding.

Preservation of the Brain.—In order that the brain may be studied to best advantage, it is necessary that it should be subjected to some hardening reagent. Methylated spirit, or a mixture of this with Müller's fluid, gives good results. The dissector must obtain a vessel large enough to hold the brain, and, at the same time, allow the hardening reagent to surround and cover it completely. It must likewise be provided with an accurately fitting lid to prevent evaporation. A small amount of cotton wadding should be arranged at the bottom of the vessel, in the form of a nest, so as to preserve, as far as possible, the natural form of the brain. The brain should be placed upon this, with its base or lower surface uppermost, and the meninges of the base should be torn across, so as to give free admission to the fluid. It is well also

to raise the cerebellum slightly from the cerebrum by means of a small pad of wadding, and it is advantageous to tear across the arachnoid at the back of the corpus callosum.

If spirit be employed, it should, in the first instance, be diluted with fully a third part of water. In three days the brain should be taken out of the vessel, and the membranes stripped from its surface. Before doing this, however, the dissector must study the manner in which the arachnoid and pia mater is disposed, and the distribution of the blood vessels. A description of these will be found in the chapter referring to the dissection of the brain. In removing the membranes from the base of the brain, the very greatest care must be taken not to injure the cranial nerves as they emerge from its substance.

The brain should now be immersed in pure spirit to complete the hardening.

Müller's fluid has the following composition, and it can readily be prepared by the student :—

Bichromate of potash, ...	25 grms.
Sulphate of soda, ...	10 grms.
Water, ...	1000 c.c.

To hasten the solution of the potassic bichromate, the water may be slightly heated, but the fluid should not be applied to the brain until it is quite cold. Methylated spirit should be added in the proportion of *one* of spirit to *three* of Müllers's fluid. To prevent the separation of the chromic salts, all light must be excluded. A relatively large quantity of the fluid must be used, and it must be changed at least three times—viz., at the end of the *first*, *fourth*, and *eighth* days.

For ordinary dissection, spirit alone is quite sufficient to give the brain a proper consistence ; but for a study of the sectional anatomy of the organ, it is best to use the Müller's fluid and spirit solution. It is true that it imparts to the brain a dark colour, but this to some extent can be removed by steeping the organ, after its removal from the hardening fluid, in a large quantity of water (and frequently changing the water) for a period of twenty-four hours. Six weeks are usually required to harden a brain in this solution ; and it is not necessary to remove the membranes until the dissector is prepared to study the organ, so great is the permeating power of the fluid.

It is best to defer the study of the brain until the dissection of the head and neck is completed.

Dura Mater at the Base of the Cranium.—The dissector has observed that the dura mater can, as a rule, be easily separated from the under surface of the cranial vault. He would find it impossible to raise it in like manner from the

base of the cranium. It is closely adherent to the crista galli, to the posterior margins of the lesser wings of the sphenoid, to the posterior clinoid processes, to the petrous portions of the temporal bones, to the basilar process of the occipital bone, and around the margin of the foramen magnum. Another cause of its close adhesion in this locality is, that it gives sheaths to the cranial nerves, and passes out of the cranium through the basal foramina to become continuous with the periosteum on the external surface of the skull. So close, indeed, is the union between the dura mater and the base of the cranium, that it would require maceration to effect a complete separation.

Partitions of Dura Mater.—The dura mater gives off, as we have already seen, processes which act as partial partitions within the cranial cavity. These are four in number, viz. :—

(1.) The falx cerebri (which has already been studied).
(2.) The tentorium cerebelli.
(3.) The falx cerebelli.
(4.) The diaphragma sellæ.

Tentorium Cerebelli.—Fig. 192 (4), and Fig. 191 (4), p. 119. This is a large crescentic fold of dura mater which constitutes a membranous roof for the posterior fossa of the cranium, and at the same time forms a partition between the posterior lobes of the cerebrum and the cerebellum. It is not horizontal. It is accurately applied to the upper surface of the cerebellum. Its highest point, therefore, is in front, in the mesial plane, and from this it gradually slopes downwards to its attached border. A very imperfect idea of its natural appearance can be obtained in the present instance, seeing that its connections have been severed in the removal of the brain. Before it is disturbed it is perfectly tense, and this tension is due to its connection with the falx cerebri. These two processes of dura mater are mutually dependent on each other in this respect—divide one and both become relaxed.

The *posterior border of the tentorium* is convex. *Behind* it is attached to the horizontal ridges which mark the deep surface of the occipital bone, and beyond this, on each side, to the posterior inferior angle of the parietal bone; *laterally* it is firmly fixed to the upper border of the petrous portion of the temporal bone. In the former situation it encloses between its two layers the lateral blood sinuses,—Fig. 192 (7)—and in the latter the superior petrosal blood sinus on each side.

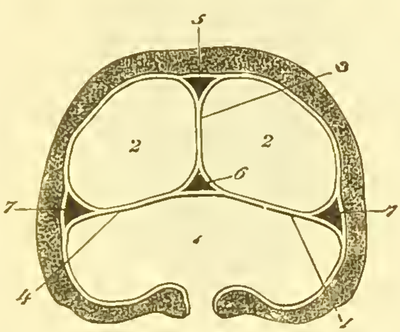

FIG. 192.—Diagrammatic coronal section through the posterior part of the cranium with the dura mater in position. (LUSCHKA.)

1. Compartment for cerebellum, &c.
2. Compartments for occipital lobes of the cerebrum.
3. Falx cerebri.
4. Tentorium.
5. Superior longitudinal sinus.
6. Straight sinus.
7. Lateral sinuses.

The *anterior border* is sharp, free, and concave (*incisura tentorii*), and forms, with the dorsum sellæ of the sphenoid, an oval opening within which the mesencephalon is placed. Beyond the apex of the petrous portion of the temporal bone the two margins of the tentorium cross each other like the limbs of the letter X; the free margin is carried forwards to be attached to the anterior clinoid process, whilst the attached border is continued inwards to be fixed to the posterior clinoid process (Fig. 193).

Falx Cerebelli.—This is a small falciform fold of dura mater placed under the tentorium, which extends forwards in the mesial plane from the internal occipital crest. It occupies the notch which separates the two lateral hemispheres of the cerebellum posteriorly. Above, it is attached to the posterior part of the under surface of the tentorium. Its anterior border is free; whilst inferiorly, it bifurcates into two small diverging ridges, which gradually fade away as they are traced forwards on either side of the foramen magnum.

The Diaphragma Sellæ is a small circular fold of the inner layer of the dura mater which forms a roof for the sella turcica. A small opening is left in its centre for the transmission of the infundibulum. An almost complete case is thus formed for the pituitary body.

Cranial Nerves.—The dissector should now turn his attention to the cranial nerves, and study the manner in which they leave the cranial cavity. Each nerve carries out with it a covering derived from each of the three membranes of the brain. In the case of the optic nerve these remain distinct; but in all the others the sheath derived from the arachnoid very soon disappears.

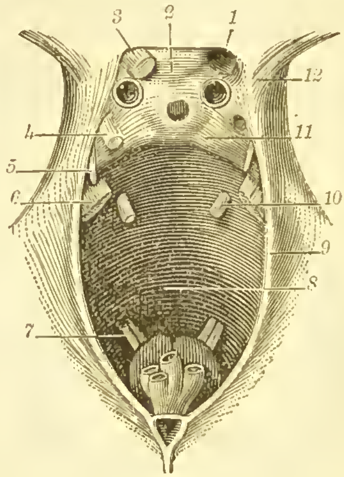

FIG. 193.—Aperture between the dorsum sellæ and the anterior concave free margin of the tentorium. (HIRSCHFELD and LEVEILLÉ.)

1. Optic foramen.
2. Olivary process of sphenoid.
3. Optic nerve.
4. Oculo-motor cranial nerve.
5. Trochlear cranial nerve.
6. Trigeminal cranial nerve.
7. Hypoglossal nerve.
8. The aperture in front of the tentorium.
9. Anterior free edge of tentorium.
10. Abducent cranial nerve.
11. Posterior clinoid process.
12. Anterior clinoid process.

Begin by examining the cribriform plate of the ethmoid. From this the olfactory bulb has been displaced in the removal of the brain. About twenty minute *olfactory nerves* proceed from the under surface of the bulb and descend into the nose through the holes in the cribriform plate. These have been ruptured close to their origin, but in all probability traces of them will be observed.

The *second* or *optic nerve*—Fig. 193 (3)—will be seen entering the orbit through the optic foramen. It is accompanied

by the ophthalmic artery, which lies below it. The student should note the strong loose sheath of dura mater which envelops the nerve.

The *third* or *oculo-motor nerve*—Fig. 193 (4)—is a firm cord-like nerve, which pierces the dura mater in front of the posterior clinoid process, within a triangular area indistinctly marked out by the intersection of the margins of the tentorium, as they pass to be attached to the clinoid processes. The nerve enters the wall of the cavernous sinus, in which it will be afterwards traced.

The minute thread-like *fourth* or *trochlear nerve*—Fig. 193 (5)—also enters the wall of the cavernous sinus, to gain which it perforates the dura mater a short distance behind, and to the outer side of the third nerve, but within the same triangular area. Its aperture of exit lies under shelter of the free margin of the tentorium.

The *fifth* or *trigeminal nerve*—Fig. 193 (6)—is composed of two parts—viz., a large, soft, sensory portion, consisting of loosely connected funiculi, and a small, firmer motor portion, which lies upon the inner surface of the sensory part. They can generally be easily distinguished, and both pierce the dura mater at the apex of the petrous portion of the temporal bone, and under the anterior extremity of the tentorium.

The *sixth* or *abducent nerve*—Fig. 193 (10)—is a small, round nerve, which disappears through the dura mater at the lower and outer part of the dorsum sellæ, and enters the wall of the cavernous sinus.

The *portio mollis*, or *auditory nerve*, the *portio dura*, or *facial nerve*, and the small *pars intermedia* all enter the auditory meatus, where the pars intermedia joins the facial nerve. They are accompanied by the auditory artery.

The *glosso-pharyngeal*, the *pneumogastric* or *vagus*, and the *spinal accessory nerves* pierce the dura mater over the internal jugular foramen in the order in which they have been named, from before backwards. The glosso-pharyngeal has a separate

aperture of exit in the dura mater, and therefore receives a separate sheath of dura mater, whilst the vagus and spinal accessory have a common aperture, and a common sheath of both arachnoid and dura mater. They all leave the skull through the middle compartment of the jugular fossa. The spinal accessory has already been noticed ascending from the spinal canal.

The *hypoglossal nerve* pierces the dura mater opposite the anterior condyloid foramen at two separate points, in the form of two distinct slips. These unite in the foramen.

Venous Blood Sinuses.—The blood sinuses which traverse the dura mater should next be examined. Each should be opened in turn by running the knife through the dura mater which forms its wall. The following is a list of these sinuses :—

1. Superior longitudinal.	6. Spheno-parietal.
2. Inferior longitudinal.	7. Circular.
3. Straight.	8. Superior petrosal.
4. Occipital.	9. Inferior petrosal.
5. Cavernous.	10. Basilar.

As already pointed out, the cranial blood sinuses are in some cases formed by a separation of the two layers of the dura mater; in other cases they are formed in the reduplications of the inner layer of the dura mater which constitute the partitions. The channels thus constituted are lined by a smooth membrane, which is continuous with the internal coat of the veins.

Torcular Herophili (confluens sinuum).—The *superior longitudinal sinus* has been already examined, except at the point where it terminates. The dissector should notice that as it descends upon the deep surface of the occipital bone, it, as a rule, inclines slightly to one or other side of the mesial plane, more usually to the right side, and in this way it terminates upon one side of the internal occipital protuberance. Here it is somewhat dilated, and then turns suddenly outwards, to form the lateral sinus of that side.

This expansion of the superior longitudinal sinus is termed the *torcular Herophili*, and it communicates by means of a transverse channel, which crosses the front of the internal occipital protuberance, with the commencement of the lateral sinus of the opposite side.

Inferior Longitudinal Sinus (sinus sagittalis inferior).—Fig. 194 (*Ssi*).—This small sinus runs backwards in the lower free border of the falx cerebri. It begins at a variable point behind the crista galli, and ends posteriorly at the anterior free edge of the tentorium, where it pours its blood into the straight sinus.

The Straight Sinus (sinus rectus) extends backwards and downwards in the mesial plane, from the anterior free edge of the tentorium to the internal occipital protuberance. Its course corresponds with the attachment of the posterior broad end of the falx cerebri to the upper surface of the tentorium. Indeed, it is formed by the opening out of the two layers of the falx on the upper surface of the tentorium. At its anterior extremity it receives the blood from the inferior longitudinal sinus and the vena magna Galeni. The latter returns the blood from the interior of the cerebrum, and its ruptured end may be noticed at the point where it enters the straight sinus (Fig. 193, p. 126). At the internal occipital protuberance, the straight sinus bends suddenly outwards, in a direction opposite to that taken by the superior longitudinal sinus, and it forms the lateral sinus of that side. A few small cerebellar veins pour their blood into the straight sinus.

Occipital Sinus (sinus occipitalis).—Fig. 194 (*So*).—This is a minute blood channel, which is placed between the layers of the falx cerebelli. Above, it opens into the *torcular Herophili*, whilst below, at the foramen magnum, it bifurcates, and the two divisions not unfrequently run forwards to join the lower end of the lateral sinus upon either side. Sometimes the occipital sinus is double throughout its whole course.

The Lateral Sinuses (sinus transversi).—Fig. 194 (*Str*).—are two in number—one on each side. They are variable in their mode of origin, but, as we have noted, the right lateral sinus is commonly formed by the superior longitudinal sinus, whilst the left is formed by the straight sinus. They commence one upon either side of the internal occipital protuberance, and communicate with each other by a transverse channel of variable width, which passes in front of this bony prominence. The sinus which represents the continuation of the superior longitudinal sinus is generally much larger than the other. From the occipital protuberance, each lateral sinus passes at first outwards and upwards, and grooves the occipital bone and the inferior angle of the parietal bone along the attached border of the tentorium. Reaching the temporal bone, it is joined by the superior petrosal sinus, and then suddenly curves downwards and inwards, in the deep furrow upon the mastoid portion of the temporal bone, and the jugular process of the occipital bone. Lastly, it turns forwards and disappears into the posterior compartment of the jugular foramen, where it terminates in the bulb of the internal jugular vein. In this course the lateral sinus describes an arch (Birmingham) with the convexity upwards, the highest point of which, as a rule, corresponds with the posterior inferior angle of the parietal bone.

Venous *tributaries* which come from the cerebellum, back part of the cerebrum, and from the diploe of the cranial bones, may be noticed opening into the lateral sinus.

Two large and important *emissary veins* connect it with the veins of the scalp, and allow its blood, when it is overcharged, to drain partly away in this direction. These are the *mastoidal vein* (emissarium mastoideum), joining it through the mastoid foramen, and the *posterior condyloid vein* (emissarium condyloideum), which joins it through the posterior condyloid foramen.

Cavernous Sinus (sinus cavernosus).—Fig. 194 (*Sc*).—It is not advisable that the dissector should open the cavernous

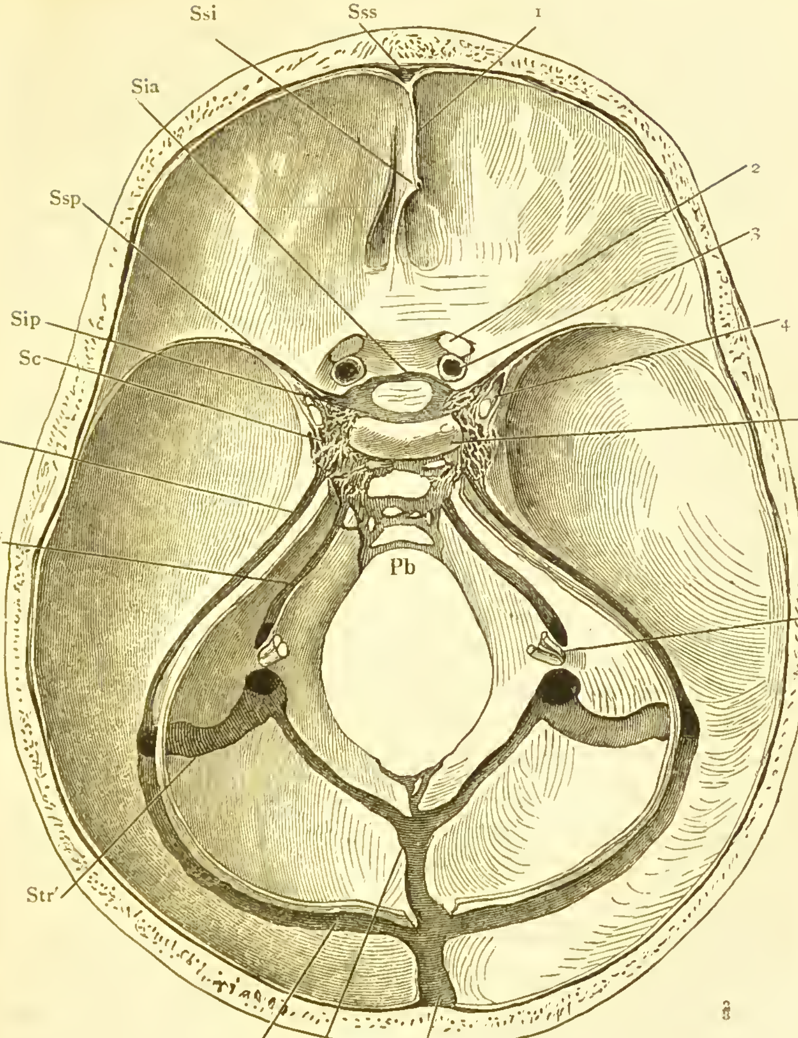

FIG. 194.—The blood sinuses of the dura mater. (HENLE.)

Sss. Superior longitudinal sinus.
Ssi. Inferior longitudinal sinus.
Sia. Anterior intercavernous sinus.
Ssp. Spheno-parietal sinus.
Sip. Posterior intercavernous sinus.
Sc. Cavernous sinus.
Sps. Superior petrosal sinus.
Spi. Inferior petrosal sinus.
Str'. } Lateral sinus.
Str. }

So. Occipital sinus.
Pb. Basilar sinus.
1. Falx cerebri.
2. Optic nerve.
3. Internal carotid artery.
4. Third cranial nerve.
5. Dorsum sellæ.
6. Eighth cranial nerve.

sinus at this stage, on account of the various nerves which pass forwards in its walls to the orbit, and which are best studied with the parts in that cavity. He should simply note, therefore, at present, that this sinus lies upon the side of the body of the sphenoid bone.

The Circular Sinus (sinus circularis)—Fig. 194 (*Sia*)—however, which surrounds the pituitary body, may be examined. It consists of two transverse channels (the anterior and the posterior intercavernous sinuses) which connect the cavernous sinuses, and lie one in front, and the other behind the infundibulum of the pituitary body.

The Petrosal Sinuses—Fig. 194 (*Sps* and *Spi*)—drain the blood from the posterior end of the cavernous sinus. They are two in number on each side—viz., superior and inferior. The *superior petrosal sinus* (sinus petrosus superior) runs along the superior border of the petrous portion of the temporal bone, and joins the lateral sinus. The *inferior petrosal sinus* (sinus petrosus inferior) is the larger of the two, but has a shorter course. It passes backwards and outwards in the groove between the basilar process of the occipital bone and the inferior margin of the petrous portion of the temporal bone. It leaves the cranial cavity by passing through the anterior compartment of the jugular foramen, and ends by joining the commencement of the internal jugular vein.

The Basilar Sinus (plexus basilaris)—Fig. 194 (*Pb*)—is not a single channel, but a plexus of minute sinuses which permeate the dura mater over the basilar process of the occipital bone. It connects the two inferior petrosal sinuses, and posteriorly communicates with the anterior intraspinal veins.

The Spheno-Parietal Sinus (sinus alæ parvæ)—Fig. 194 (*Ssp*)—is a minute blood channel which runs inwards under shelter of the lesser wing of the sphenoid bone. Externally it commences in one of the small meningeal veins, whilst internally it pours its blood into the fore part of the cavernous

sinus. Owing to its position, this sinus is somewhat difficult to demonstrate.

Arteries entering the Cranial Cavity.—The student has now examined the various channels by means of which the venous blood is drained out of the cranial cavity. He should next examine the arteries which introduce the blood into this cavity. These are—

1. The vertebral arteries.
2. The internal carotid arteries.
3. The meningeal arteries.

The Vertebral and Internal Carotid Arteries carry blood for the supply of the encephalon and the parts within the orbit. The *internal carotid artery* will be observed piercing the dura mater immediately behind, and to the inner side of the anterior clinoid process. At this point it gives off its ophthalmic branch which accompanies the optic nerve through the optic foramen, and immediately beyond this the internal carotid trunk has been severed in the removal of the brain. The *vertebral artery* will be observed piercing the dura mater immediately below the foramen magnum. It also has been divided close to its point of entrance.

Meningeal Arteries.—These are the nutrient arteries of the dura mater, and the inner table and diploe of the cranial bones. They are derived from a great number of different sources, but the only one of any size is the *middle meningeal*, which comes from the internal maxillary artery. The others are small twigs, and, except in a well injected subject, will not be easily made out. They are:—(1) *anterior meningeal* from the anterior ethmoidal artery; (2) the *small meningeal* from the internal maxillary artery; (3) some small branches from the ascending pharyngeal, occipital, and vertebral arteries.

The *middle meningeal artery* (arteria meningea media), a branch of the internal maxillary artery, enters the cranium through the foramen spinosum of the sphenoid, and divides into two large terminal branches. Of these, the anterior

branch ascends upon the great wing of the sphenoid, and the anterior inferior angle of the parietal bone, grooving both deeply, whilst the posterior branch turns backwards upon the squamous portion of the temporal bone. The wide distribution of these vessels in the dura mater has already been noticed.

Two *veins* accompany the middle meningeal artery. Above, these vessels communicate with the superior longitudinal sinus (Testut), whilst below, they unite in a common trunk which joins the pterygoid plexus.

The *anterior meningeal artery* (arteria meningea anterior) proceeds from the anterior ethmoidal artery as it lies on the cribriform plate of the ethmoid bone, along with the nasal nerve. It supplies a limited area of dura mater in the anterior fossa of the cranium.

The *small meningeal artery* (ramus meningeus accessorius) is somewhat inconstant, and not unfrequently springs from the middle meningeal. It enters the cranium through the foramen ovale, but it should not be looked for at the present stage, as it is best examined along with the Gasserian ganglion and the three divisions of the trigeminal nerve.

The *meningeal branches from the ascending pharyngeal artery* are the terminal twigs of this vessel, and enter the cranium through the foramen lacerum medium, through the jugular foramen, and through the anterior condyloid foramen. The branch which passes through the jugular foramen is the largest.

The *meningeal branches of the occipital and vertebral arteries* are small. The former enters through the jugular foramen, whilst the latter gains admittance to the cranium through the foramen magnum, and is distributed in the posterior cranial fossa.

Pituitary Body (*hypophysis cerebri*)—Fig. 195.—The overhanging margin of the diaphragma sellæ should be freely cut in two or three places, and the pituitary body carefully dislodged from the sella turcica of the sphenoid bone. If

this be done successfully, the body will be seen to be an oval structure, slightly flattened from above downwards, and with its long axis directed transversely. Further, it may be noticed to consist of a large anterior lobe, and a smaller posterior lobe. The former of these is hollowed out behind so as to form a concavity for the lodgment of the latter. If a horizontal section be made through the body, the line of separation between the two lobes is very distinct. The infundibulum which connects the pituitary body with the tuber cinereum of the brain is continued into the posterior

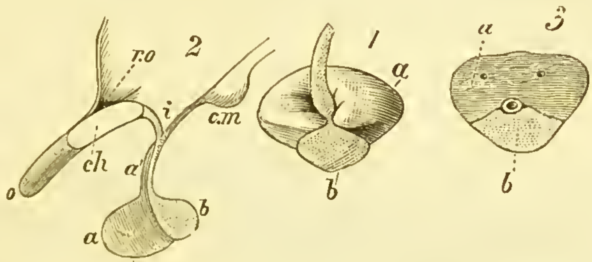

FIG. 195.—1. Pituitary body; 2. In mesial section; 3. In horizontal section. (SCHWALBE.)

a. Anterior lobe.
b. Posterior lobe.
cm. Corpus mammillare.
i. Tuber cinereum.
ch. Optic commissure in section.
ro. Optic recess of the third ventricle.
o. Optic nerve.
a'. Infundibulum with projection from anterior lobe upwards in front of it.

lobe, and is in no way structurally continuous with the larger anterior lobe. Thus, even in the adult, we have a clue to the different modes of development of the two lobes. The posterior lobe is derived from the brain, whilst the anterior lobe is an off-shoot from the primitive buccal cavity.

The dissectors of the head and neck must now prepare for the changing of the position of the subject. Some tow, or a sponge, soaked in a mixture of methylated spirit and carbolic acid, should be introduced into the cranial cavity. The skull-cap should then be replaced and retained in position by bringing the scalp flaps over it, and stitching them accurately together. It is a very common practice with students,

when the scalp has been dissected and the brain removed, to throw the skull-cap aside. This proceeding cannot be too strongly condemned, because the contour of the head is then lost, and in the subsequent dissection false conceptions are apt to be formed.

DORSAL ASPECT OF THE TRUNK.

On the third day after the subject has been placed in the dissecting-room its position is changed. It is now laid on its face, with its chest and pelvis supported by blocks. The head should be allowed to fall well over the end of the table (Fig. 196). During the four days that the

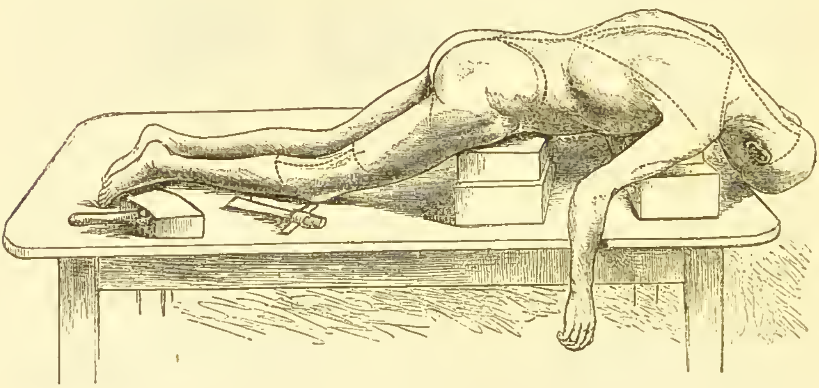

FIG. 196.

body is allowed to lie in this position, the dissectors of the head and neck have to dissect the dorsal aspect of the cervical, thoracic, lumbar and sacral regions, and in addition, remove the spinal cord. The dissectors of the upper limbs take part in this dissection. It is their duty to dissect the superficial and deep fasciæ in the thoracic and lumbar regions, and also those structures which connect the limb to the trunk posteriorly. To them, therefore, belong the trapezius muscle below the seventh cervical spine, the latissimus dorsi and the rhomboid muscles, together with their vessels and nerves of supply. The levator anguli scapulæ,

and the omo-hyoid are to be regarded as common property. The dissectors of the upper limbs are allowed two days to complete this work.

During the first two days allowed for the dissection of the back, the dissector of the head and neck has merely to examine the superficial parts on the back of the neck, and take part along with the dissector of the upper limb in the dissection of those structures which are common to both.

The *first day* should be devoted to the reflection of the skin, and the dissection of the superficial nerves and that portion of the posterior triangle of the neck which can be examined in the present position of the subject. On the *second day* the trapezius may be reflected, and the following structures examined—viz., the levator anguli scapulæ and its nerves, the posterior scapular artery, the superficial cervical artery, the supra-scapular artery and nerve, the transversalis colli artery, and the origin of the omo-hyoid.

Surface Anatomy.—First make out the position of the external occipital protuberance, and having traced the superior curved line of the occipital bone as it passes outwards towards the mastoid process, press deeply into the neck immediately below the occiput, and in the middle line; here the bifid extremity of the massive spinous process of the axis vertebra can be felt. Carrying the finger downwards, the posterior edge of the ligamentum nuchæ can be distinguished, but the short spines of the third, fourth, and fifth cervical vertebræ can hardly be detected. The spines of the sixth and seventh cervical vertebræ, however, are usually very prominent.

Reflection of Skin (Fig. 196).—Three incisions are required—(1) Along the middle line, from the external occipital protuberance to the prominent spine of the seventh cervical vertebra. (2) From the lower end of this mesial incision transversely outwards to the inner border of the acromion process of the scapula. (3) From the upper end of the primary incision transversely outwards over the occiput to the ear.

The quadrilateral flap of skin thus marked out must be raised from the subjacent superficial fascia. On reaching the side of the neck, the

head must be held well over to the opposite side. Here, unless the dissector keep close to the skin, there is a danger of the knife slipping in under the posterior border of the sterno-mastoid muscle.

Superficial Nerves.—The nerves to be looked for in the superficial fascia, which is now exposed, are derived partly from the posterior primary divisions, and partly from the anterior primary divisions of the cervical nerves. They are :—

From posterior primary divisions.	1. Great occipital. 2. Terminal twigs of the internal branches of the third, fourth, and fifth nerves.
From anterior primary divisions.	1. Small occipital. 2. Great auricular.

Dissection.—The main trunk of the great occipital nerve may be found piercing the trapezius about an inch below the occipital protuberance, and about half-an-inch external to the mesial plane. The fascia at this spot is usually very dense, and the readiest method to adopt in exposing the nerve is to carefully shave it off in slices until the plane of the muscle is reached.

The *great occipital*—Fig. 197 (8)—is the internal branch of the posterior primary division of the second cervical nerve, and its branches of distribution have already been noticed, spreading out on the back of the scalp (p. 109). As it becomes superficial, it joins the occipital artery, and both are directed upwards to supply the scalp.

The terminal twigs of the internal branches of the posterior divisions of the third, fourth, and fifth cervical nerves enter the superficial fascia close to the mesial plane, and then turn transversely outwards to supply the skin of the neck.

The *third cervical branch* sends in addition a large twig upwards to the integument over the occiput. This nerve runs along the inner side of the great occipital, and, as a rule, communicates with it. From its distribution, it is frequently termed the *third occipital nerve.*

Dissection.—The small occipital nerve will be found by dividing the fascia along the posterior border of the sterno-mastoid muscle.

The *small occipital nerve*—Fig. 197 (9)—springs from the anterior primary division of the second cervical nerve, and runs upwards to assist in the supply of the integument over the occiput. Its terminal twigs have already been dissected in the superficial fascia of the scalp (p. 109). Occasionally the small occipital is represented by two separate nerves.

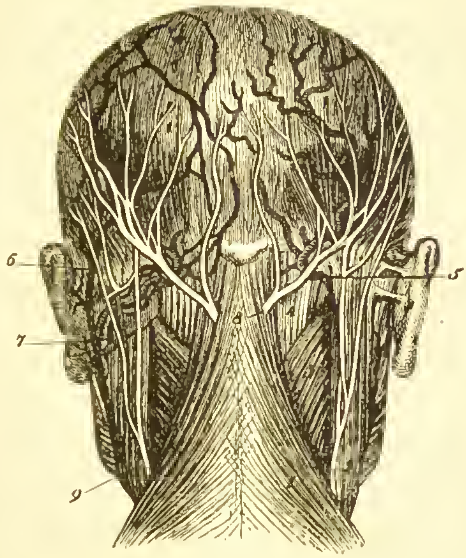

FIG. 197.—Superficial dissection of the posterior aspect of the neck and head. (LUSCHKA.)

1. Trapezius.
2. Sterno-mastoid.
3. Splenius capitis.
4. Complexus.
5. Occipital artery.
6. Posterior auricular vein.
7. Occipital vein.
8. Great occipital nerve.
9. Small occipital nerve.

Dissection.—The great auricular nerve can readily be exposed by drawing the head well over to the opposite side and then dividing the fascia over the outer surface of the sterno-mastoid muscle very obliquely. Begin the incision at the posterior margin of the muscle about the middle of the neck, and carry it upwards and forwards towards the lobule of the ear.

Great auricular or auriculo-parotidean nerve—Fig. 186 (9).—The great auricular nerve is a branch of the cervical

plexus, and takes origin from the second and third cervical nerves. Turning round the posterior border of the sterno-mastoid muscle, it proceeds upwards and forwards on the surface of that muscle towards the lobule of the ear. Near this point it will be found to end by dividing into three sets of branches—viz., facial, auricular, and mastoid.

The *facial branches* will be traced afterwards in the dissection of the face. The others may be followed, however, at the present stage. The *auricular branches* supply the integument upon the cranial aspect of the auricle, and if they be carefully dissected, several of them will be noticed to pierce the cartilage to reach the integument on its outer surface. Communications may also be made out between these twigs and the posterior auricular branch of the facial nerve. The *mastoid branch* extends upwards upon the mastoid process, where it is connected with the posterior auricular and small occipital nerves.

Dissection.—Whilst the subject is lying upon its face we can only obtain a very meagre idea of the posterior triangle of the neck. It is only its upper and least important part which can at present be exposed. To bring the boundaries, floor and contents, of this portion into view, the dissector should begin by cleaning the cervical part of the trapezius. Occupying the interval between the trapezius and sterno-mastoid, two contiguous muscles, taking a somewhat oblique course, will be observed. The higher of these is the splenius capitis, and the lower is the levator anguli scapulæ. These, together with the posterior border of the sterno-mastoid, must be cleaned. In carrying out this dissection the dissector must proceed with some degree of caution ; and above all, he must be careful not to raise the sterno-mastoid nor disturb the cervical nerves which lie under cover of it, because these can be studied at much greater advantage when the subject is turned. In cleaning the levator anguli scapulæ the dissector must secure two small nerves which issue from the cervical plexus for the supply of that muscle. They are closely applied to its surface, and are apt to be removed with the fascia covering the muscle, unless they are specially looked for. Further, the spinal accessory nerve, and two or three cervical nerves crossing from the posterior border of the sterno-mastoid to the trapezius, should be dissected out.

The Posterior Triangle, of which the upper part is thus displayed, is bounded *in front* by the posterior border of the sterno-mastoid, and *behind* by the anterior border of the trapezius. The *apex*, which is directed upwards, is formed at the superior curved line of the occipital bone by the apposition of the occipital attachments of these two muscles. The *floor* of that portion of the space which is exposed will be observed to be formed by the splenius capitis and the levator anguli scapulæ. But it often happens that the occipital attachments of the sterno-mastoid and trapezius (more especially of the latter) are so poorly developed that they fail to meet on the superior curved line of the occipital bone. In this case a small portion of the complexus (readily recognised by the vertical direction of its fibres) will be noticed entering into the formation of the floor of the space above the level of the splenius. The *contents* of the space, in so far as they can be seen in the present position of the body, are—(1) the great auricular and small occipital nerves as they appear at the posterior margin of the sterno-mastoid muscle; (2) the spinal accessory nerve, the cervical nerves to the trapezius, and two small nerves from the cervical plexus to the levator anguli scapulæ. An additional structure also enters the space when the sterno-mastoid and trapezius do not meet to form a distinct apex for the triangle, viz., the occipital artery. In such a case a small portion of the vessel will be noticed upon the complexus muscle, close to the superior curved line of the occipital bone.

The Spinal Accessory Nerve appears in the posterior triangle by emerging from the substance of the sterno-mastoid muscle. It crosses the triangle obliquely, running from above downwards and backwards, and finally disappears under the anterior border of the trapezius.

The Cervical Branches to the Trapezius, two or three in number, spring from the third and fourth cervical nerves. They enter the posterior triangle by leaving the shelter of

the sterno-mastoid, and are carried downwards and backwards across the space parallel with, but at a lower level than, the spinal accessory nerve. This, together with the fact that they are somewhat smaller than the spinal accessory, is sufficient to distinguish them from that nerve. They finally disappear under the anterior border of the trapezius.

Dissection.—On the second day after the subject has been placed on its face, the trapezius may be reflected. This must be done in conjunction with the dissector of the arm. First separate the muscle from the occipital bone, and then divide it about half-an-inch from the spines of the vertebræ The muscle can now be raised and thrown outwards towards its insertion. On its deep surface the spinal accessory nerve, the cervical nerves of supply, and the superficial cervical artery will be noticed. It is the duty of the dissector of the upper limb to dissect these, but the dissector of the head and neck should trace the superficial cervical artery to its origin from the transversalis colli.

The attachments of the levator anguli scapulæ must also be defined. Two nerve-twigs from the cervical plexus, which lie on its surface and finally enter its substance, have already been secured. Further, passing downwards under cover of this muscle, the *nerve to the rhomboids* and the *posterior scapular artery* will be found. Almost invariably the *nerve to the rhomboids* gives one or two twigs to the levator anguli scapulæ.

The Levator Anguli Scapulæ (levator scapulæ) arises by four slips from the posterior tubercles of the transverse processes of the upper four cervical vertebræ. These unite to form an elongated muscle which extends downwards and backwards to be inserted into that portion of the vertebral border of the scapula which is placed above the root of the spine. As already noted, the nerve supply of the levator anguli scapulæ comes from the third and fourth cervical nerves, and also from the nerve to the rhomboids.

The Transversalis Colli Artery will be seen terminating near the outer margin of the levator anguli scapulæ, by dividing into the *superficial cervical* and *posterior scapular arteries.* The former of these proceeds upon the superficial aspect of the levator anguli scapulæ, whilst the latter passes under cover of that muscle. It is the duty of the dissector

of the upper limb to trace the further course of these branches of the transversalis colli artery.

Dissection.—The posterior belly of the omo-hyoid muscle, and the supra-scapular artery and nerve can now be displayed by dissecting towards the upper margin of the scapula. This dissection must be effected in conjunction with the dissector of the upper limb, and it is well not to expose these structures at the present stage for more than an inch from the upper border of the scapula.

The Posterior Belly of the Omo-hyoid Muscle is a slender muscular band which arises from the upper border of the scapula, immediately behind the supra-scapular notch. It also derives fibres from the ligament which bridges across this notch. The further connections of the omo-hyoid will be studied in the dissection of the triangles of the neck after the body has been turned.

The Supra-scapular Artery and Nerve.—The *supra-scapular artery* will be noticed to enter the supra-spinous fossa of the scapula, by passing over the supra-scapular ligament. The *supra-scapular nerve*, on the other hand, is carried into the fossa under cover of the ligament.

The *second day's* work is now completed, and on the *same day* the dissector of the upper limb must finish his share of the dissection of the back, so as to allow the dissector of the head and neck to begin the examination of the deeper structures on the dorsal aspect of the trunk.

Two days are allowed for this dissection, and these may be disposed of in the following manner:—On the *first day*, all the muscles, fasciæ, nerves, and blood vessels of the back, with the exception of those in connection with the sub-occipital triangle, should be studied; on the *second day*, the sub-occipital space must be examined, and the spinal cord displayed. Should the dissector find that the work is greater than he can undertake in the allotted time, the sub-occipital space may be left over until the head and neck is removed from the trunk.

Serrati Muscles.—These are two thin sheets of fleshy fibres, which are placed upon the posterior aspect of the thoracic wall. The *serratus posticus superior* (serratus posterior superior) is much the smaller of the two; it arises by a thin aponeurotic tendon —(1) from the lower part of the ligamentum nuchæ; (2) from the spinous process of the

seventh cervical vertebra ; and (3) from the spinous processes of the upper two or three dorsal vertebræ. From this origin it proceeds obliquely downwards and outwards, and is inserted by distinct digitations into the outer surfaces of four ribs—viz., the second, third, fourth, and fifth—a short distance in front of their angles.

The *serratus posticus inferior* (serratus posterior inferior) will be brought into view by raising and throwing inwards that portion of the latissimus dorsi which the dissector of the upper limb has left attached to the lumbar fascia. The serratus posticus inferior will then be observed to take origin from the spinous processes of the last two dorsal and upper two lumbar vertebræ, as well as from the supra-spinous ligaments which stretch between these bony prominences. The dissector will note, however, that this is not an independent and distinct attachment, but that it is effected through the medium of the vertebral aponeurosis and posterior lamella of the lumbar fascia, with both of which the aponeurotic tendon of the muscle blends. The precise extent of the origin is thus rendered somewhat obscure. The serratus posticus inferior is directed upwards and outwards, and is inserted by four digitations into the lower borders of the four lower ribs.

Vertebral Aponeurosis.—The connections of the *vertebral aponeurosis* can be easily made out. It is the strong, but thin and transparent fascia, which bridges across the hollow between the spinous processes of the dorsal vertebræ and the portions of the ribs which lie internal to their angles. It confines in this hollow the proper muscles of the spine and head. Make a transverse incision through it about the middle of the dorsal region, and introduce under it the handle of a knife. By carrying this first in an inward and then in an outward direction, the attachment of the aponeurosis to the spines of the dorsal vertebræ and to the angles of the ribs will be rendered manifest. In the next place, note that when it is followed in an upward

and downward direction the fascia presents a different relation to the two serrati muscles. Superiorly it proceeds *under cover of* the serratus posticus superior and the splenius muscles, and is lost in the deep layers of fascia of the neck; inferiorly *it blends* with the aponeurotic tendons of the serratus posticus inferior and the latissimus dorsi, and with these forms the posterior lamella of the lumbar fascia.

The Lumbar Fascia is an exceedingly dense aponeurotic structure, which gives great support to the muscles of the loins, and also serves as a means of origin for two of the flat muscles of the abdominal wall—viz., the transversalis abdominis and obliquus internus. It is attached internally to the vertebral column by three distinct lamellæ, which are separated from each other by intervening muscular masses. The *posterior* or *superficial lamella* is at present seen in the form of a strong opaque aponeurotic sheet stretching outwards from the lumbar spines. It is formed, as we have already observed, by a continuation downwards of the vertebral aponeurosis, and by a union of this with the aponeurotic tendons of the latissimus dorsi and the serratus posticus inferior. Divide this lamella in a longitudinal direction about one inch external to the middle line, and raise it from the subjacent erector spinæ muscle.

Mesially it will be seen to have a strong attachment to the tips of the lumbar spines and the intervening supraspinous ligaments, whilst inferiorly it is fixed to the back part of the crest of the ilium, and to the subjacent tendon of the erector spinæ, where this lies upon the dorsum of the sacrum.

The erector spinæ should now be pushed inwards either with the fingers or with the handle of a knife. This proceeding will bring into view the *second* or *middle lamella* of the lumbar fascia. Further, the union of the posterior and middle lamellæ beyond the outer border of the erector spinæ, and the attachment of the middle lamella to the tips of the transverse processes of the lumbar vertebræ, may be

seen. Note, however, that whilst the main attachment of this lamella is to the apices of the transverse processes, it also extends inwards between them and is attached to their contiguous margins. The next step consists in dividing the middle lamella longitudinally close to its vertebral attachment. The quadratus lumborum is then brought into view, and gently raising the middle lamella from the surface of this muscle until its outer border is exposed, the whole muscle should be pushed inwards. This brings into view

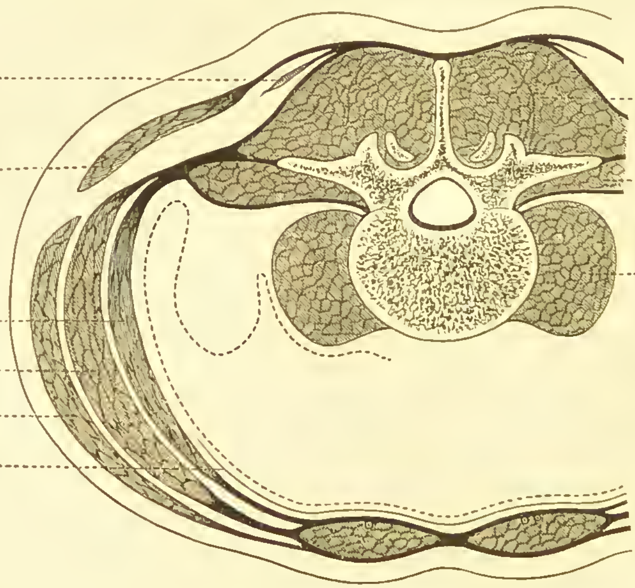

FIG. 198.—Diagram to show the connections of the lumbar fascia.

the *third* or *anterior lamella* of the lumbar fascia, and its junction on the one hand with the middle lamella, and on the other with the bodies of the lumbar vertebræ close to the roots of the transverse processes, can be made out.

The *lumbar fascia*, therefore, is formed at the outer borders of the erector spinæ and quadratus lumborum muscles by the union of these three lamellæ. Superiorly, it is attached to the last rib; inferiorly, it is fixed to the crest of the ilium; whilst externally it is continued into the

transversalis abdominis muscle, of which it may be considered to be the posterior aponeurosis. By its superficial surface it gives origin to fibres of the internal oblique muscle of the abdominal wall.

Dissection.—The serratus posticus superior must be divided close to its origin from the vertebral spines, and turned outwards in order that the splenius muscle may be displayed.

Splenius Muscle.—The splenius has a continuous origin from rather more than the lower half of the ligamentum nuchæ, and from the spines of the seventh cervical and upper six dorsal vertebræ. From this the fibres pass obliquely upwards and outwards in the form of a thick, flat muscle, which soon divides into a cervical and a cranial portion. These are termed respectively the splenius colli and the splenius capitis.

The *splenius colli* (splenius cervicis) turns forwards and is inserted, behind the levator anguli scapulæ, by tendinous slips, into the posterior tubercles of the transverse processes of the upper two or three cervical vertebræ.

The *splenius capitis* passes under cover of the upper part of the sterno-mastoid muscle, and gains insertion into the lower part of the mastoid process and into the outer portion of the superior curved line of the occipital bone. To obtain a view of this insertion, the sterno-mastoid muscle may be divided along the superior curved line of the occipital bone as far as the mastoid process. Upon no account, however, detach it from the mastoid process.

Dissection.—The erector spinæ and complexus muscles must now be dissected. Begin by reflecting the splenius muscle. Detach it from its origin and throw it outwards and upwards towards its insertion. In doing this preserve the cutaneous branches of the cervical nerves which pierce it.

When the splenius capitis is fully reflected, a small triangular space will be noticed close to the superior curved line of the occipital bone. In front, it is bounded by the trachelo-mastoid muscle; behind, by the outer border of the complexus; and above, by the superior curved line of the occipital bone. The floor of this little space is formed by the

superior oblique muscle of the head, and it is traversed by the occipital artery which in this part of its course gives off its arteria princeps cervicis branch.

Next remove the vertebral aponeurosis and turn the latissimus dorsi, the serratus posticus inferior, and the superficial lamella of the lumbar fascia outwards.

Erector Spinæ (sacro-spinalis).—Under this name we include a series of muscular strands which stretch with a greater or less degree of continuity along the entire length of the dorsal aspect of the spinal column. In the lumbar region it constitutes a bulky fleshy mass which may be considered the starting point. This bulky mass sends a pointed process downwards on the back of the sacrum, and has the following origin :—(1) from the spines of the lower two dorsal, all the lumbar and all the sacral vertebræ; (2) from the supra-spinous ligaments which bind the lumbar and dorsal spines together; (3) from the back of the sacrum and from the posterior sacro-coccygeal ligament; (4) from the posterior fifth of the iliac crest. In great part the superficial surface of this muscular mass is covered by a very dense tendon, which in its lower part becomes blended, as already noted, with the superficial lamella of the lumbar fascia.

As the erector spinæ is followed upwards it is seen to divide into three columns. The outer column first separates from the general mass, and to it the name of *ilio-costalis* is given; the middle column is termed the *longissimus*, and the inner column, which only becomes quite distinct as we approach the upper part of the dorsal region, is called the *spinalis dorsi*.

Ilio-costalis (ilio-costalis lumborum).—The intermuscular interval between this muscle and the longissimus becomes apparent about the level of the last rib. The separation is rendered all the more distinct from the external branches of the posterior primary divisions of the dorsal spinal nerves appearing in the interval. Turn the muscle

outwards with the handle of the knife, and clean its slips of insertion. The nerves must at the same time, be carefully preserved.

The *ilio-costalis* will now be observed to end in six or seven tendinous slips, which are inserted into the angles of the six or seven lower ribs. But wherever the ilio-costalis drops one of these slips, another tendinous slip takes origin from the upper border of the same rib. In this way a second muscle is formed, which continues the outer column of the erector spinæ upwards. This muscle is called the *musculus accessorius.*

The Musculus Accessorius (ilio-costalis dorsi), therefore, arises close to the inner side of the ilio-costalis by six tendinous slips from the upper borders of the six lower ribs. It terminates in tendons which are inserted into the angles of the upper six ribs, and also into the transverse process of the lowest cervical vertebra.

Cervicalis Ascendens (ilio-costalis cervicis).—This muscle may be looked upon as the continuation of the outer column upwards into the neck. It arises close to the inner side of the accessorius by four slips from the third, fourth, fifth, and sixth ribs, and is inserted into the posterior tubercles of the transverse processes of the fourth, fifth, and sixth cervical vertebræ.

Longissimus Dorsi.—The longissimus dorsi is the largest of the three divisions into which the erector spinæ splits, and it extends upwards as high as the first dorsal vertebra. It is inserted by two distinct rows of tendinous and fleshy slips. The *inner row* consists of a series of tendons attached in the dorsal region to the tips of the transverse processes of all the dorsal vertebræ, and in the loin to the accessory processes of the lumbar vertebræ ; the *outer row* is composed of fleshy slips, which are inserted in the dorsal region into the lower ten ribs, midway between their tubercles and angles, and in the loin to the transverse processes of the lumbar vertebræ and to the middle layer of the

lumbar fascia. But this muscular column does not end in the dorsal region; it is carried up into the neck, and even reaches as high as the mastoid process of the skull by two muscular continuations termed respectively—(1) the transversalis cervicis, and (2) the trachelo-mastoid.

Transversalis Cervicis (longissimus cervicis).—This muscle takes origin in the upper dorsal region, by four or five slips from the transverse processes of a corresponding number of the upper dorsal vertebræ, and it gains insertion into the posterior tubercles of the transverse processes of all the cervical vertebræ, with the exception of the first and the last.

The Trachelo-mastoid (longissimus capitis) is prolonged upwards in the neck under cover of the splenius. Its origin from the transverse processes of three or four of the upper dorsal vertebræ is intimately associated with that of the transversalis cervicis. In addition to its dorsal origin, however, it also draws three or four slips from the articular processes of a like number of the lower cervical vertebræ. The narrow fleshy band which results is inserted into the back part of the mastoid process, under cover of the splenius capitis and sterno-mastoid muscles.

Spinalis Dorsi.—This, the innermost, shortest, and weakest of the three columns, is in some respects the most difficult to define. Below, it is intimately blended with the longissimus dorsi, but it may be regarded as taking origin by four tendons from the spines of the two upper lumbar and two lower dorsal vertebræ. These, by their union, form a small muscle, which is inserted by a series of slips into a very variable number of the upper dorsal spines. It is closely connected with the subjacent semispinalis dorsi.

Dissection.—The occipital artery has already been observed crossing the apex of the posterior triangle (p. 141), and its terminal branches have been dissected as they ramify in the scalp (p. 111). The second part of the vessel, which extends from under shelter of the mastoid process, along the superior curved line of the occipital bone, to the

point where it pierces the trapezius to become superficial, can now be fully exposed. To effect this, the trachelo-mastoid must be divided a short distance below its insertion, and along with the splenius capitis thrown upwards as far as possible.

Occipital Artery (arteria occipitalis).—The second part of the occipital artery is now displayed. In the region of the mastoid process it is very deeply placed; indeed, no less than five structures lie superficial to it. These are (enumerating them in order from the vessel outwards) —(1) the origin of the posterior belly of the digastric muscle; (2) the mastoid process; (3) the trachelo-mastoid; (4) the splenius capitis; and (5) the sterno-mastoid.[1] As the artery runs backwards, it very soon emerges from under cover of the first three of these structures, and a little farther on it leaves the shelter of the splenius; so that it is covered by the sterno-mastoid alone. Issuing from under cover of the posterior border of this muscle, the artery crosses the apex of the posterior triangle, and disappears under the trapezius, which it finally pierces near the external occipital protuberance, to reach the scalp. Two muscles constitute its deep relations—viz., the insertion of the superior oblique and the complexus.

The following *branches* may be traced from this portion of the occipital artery :—

1. Arteria princeps cervicis.
2. Mastoid.
3. Muscular.

The *arteria princeps cervicis* (ramus descendens) is a twig of some size, which gives off a small branch to the deep surface of the splenius, and then sinks under cover of the complexus, where it will be subsequently dissected.

The small *mastoid artery* (ramus mastoideus) enters the

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[1] It is not uncommon to find the artery at this point of its course nearer the surface. It may pass backwards between the splenius and the trachelo-mastoid.

mastoid foramen to supply the diploe and the meninges of the brain.

The *muscular twigs* go to the neighbouring muscles.

The *veins* corresponding to the occipital artery are two, or perhaps three in number. They drain the blood from the occipital portion of the scalp, and open into the large *vena profunda cervicis*. The outermost of the occipital veins effects, as a general rule, a communication (emissarium mastoideum) with the lateral sinus through the mastoid foramen.

Dissection.—In cleaning the complexus muscle, and in defining its attachments, care must be taken of the internal branches of the posterior primary divisions of the second, third, fourth, and fifth cervical nerves. The first of these—or, in other words, the great occipital—from its great size, runs little risk of injury, but the others are liable to be overlooked. They all emerge from the substance of the muscle close to the mesial plane.

The Complexus Muscle, placed in the cervical and upper dorsal regions, inclines obliquely upwards and inwards to its insertion into the occiput. It arises by seven tendinous slips from the transverse processes of the last cervical and upper six dorsal vertebræ, and by three slips from the articular processes of the fourth, fifth, and sixth cervical vertebræ. A thick fleshy muscle is thus formed, and this is inserted into a large, somewhat oval impression between the superior and inferior curved lines of the occipital bone, close to its crest. The muscle narrows somewhat as it passes upwards, and is separated from its neighbour of the opposite side by the ligamentum nuchæ.

The inner portion of the muscle, which is to a certain extent distinct from the general mass, and is divided into two bellies by an intermediate tendon, is frequently designated the *biventer cervicis*.

Dissection.—The complexus must now be reflected by detaching it from the occiput and throwing it outwards. This dissection requires great care, not only on account of the nerves which have been seen to perforate it to reach the surface, but also on account of the structures which it covers. In its upper part it lies over the sub-occipital triangle and the muscles bounding it, whilst below it covers the semispinalis

muscle. A thick dense fascia is placed over these subjacent parts, and in this we find certain of the cervical nerves and the anastomosis between the arteria princeps cervicis and arteria profunda cervicis. The dissector must specially look for a small twig from the sub-occipital nerve which enters the deep surface of the upper part of the complexus, and for a larger branch to the same muscle from the great occipital

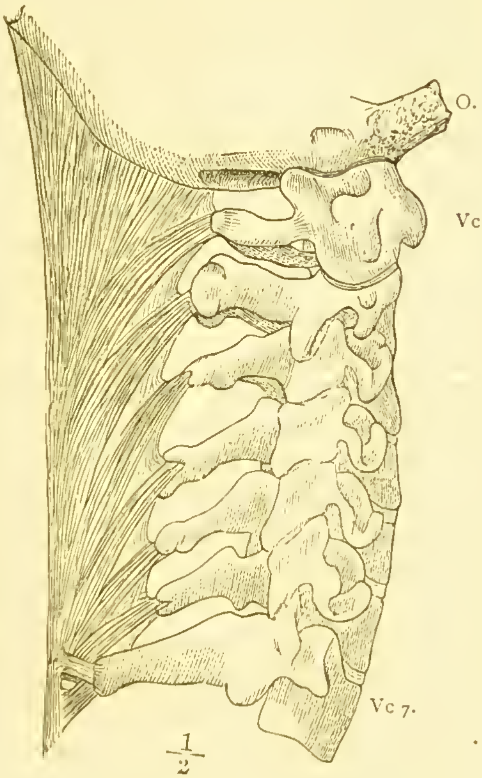

FIG. 199.—Ligamentum nuchæ. (CRUVEILHIER.)

O. Occipital bone.
Vc 1. First cervical vertebra.
Vc 7. Seventh cervical vertebra.

nerve. The inner margin of the complexus will be seen to be in contact with a mesial fibrous partition which separates it from the corresponding muscle of the opposite side. This is the ligamentum nuchæ.

The Ligamentum Nuchæ (Fig. 199) is a strong fibrous partition placed in the mesial plane between the muscles on the

back of the neck. It represents a powerful elastic structure in quadrupeds, which helps to sustain the weight of the dependent head. In man, however, there is not much elastic tissue developed in connection with it, and it appears to be a continuation upwards of the supraspinous ligament from the spine of the seventh cervical vertebra to the external occipital protuberance. In shape it is somewhat triangular. By its base it is attached to the crest of the occipital bone; by its anterior border it is fixed by a series of slips to the posterior tubercle of the atlas, and to the bifid spines of the cervical vertebræ in the intervals between their tubercles. Its apex is formed by its attachment to the spine of the seventh cervical vertebra, whilst its posterior border is in a measure free and gives origin to the trapezius, rhomboid, serratus posticus superior, and splenius muscles.

Arteria Princeps Cervicis and Arteria Profunda Cervicis.—The *deep cervical artery* springs from the superior intercostal branch of the subclavian, and reaches the dorsum by passing backwards between the transverse process of the last cervical vertebra and the neck of the first rib. At the present stage of the dissection it is seen ascending upon the semispinalis colli muscle and anastomosing with the *arteria princeps cervicis.* The latter artery, as we have seen, is a branch of the occipital. Both vessels likewise anastomose with twigs from the vertebral artery.

The arteria profunda cervicis is accompanied by a large vein—the *vena profunda cervicis.* This vessel begins in the sub-occipital region, where it is joined by the occipital veins, and it ends in the vertebral vein close to its termination. It reaches this point by turning forwards under the transverse process of the last cervical vertebra.

Posterior Primary Divisions of the Spinal Nerves.—The nerves of the back must now be examined. They are the posterior primary divisions of the spinal nerves. With *four* exceptions (viz., the first cervical, fourth and fifth sacral,

and the coccygeal nerves), each posterior division will be found to divide into an *external* and an *internal branch.*

Examine these nerves successively in the cervical, dorsal, and lumbar regions. It is well, however, to defer the dissection of the sacral and coccygeal nerves until the multifidus spinæ muscle has been studied.

Cervical Region.—Here the posterior primary divisions of the spinal nerves are eight in number. The posterior division of the *first* or *sub-occipital nerve*, which, as we have seen, fails to divide into an external and an internal branch, lies deeply in the sub-occipital triangle, and will be examined when this space is dissected.

The posterior primary division of the *second cervical nerve* is very large, and appears between the neural arches of the atlas and axis vertebræ. The posterior primary divisions of the succeeding *six cervical nerves* arise from the corresponding spinal nerve-trunks in the intervertebral foramina a short distance further out, and, turning backwards under cover of the posterior intertransverse muscles, appear in the intervals between the transverse processes.

The *external branches* are of small size, and are entirely devoted to the supply of muscles. They give twigs to the splenius colli and to the cervical and cranial prolongations of the erector spinæ.

The *internal branches* are not all distributed alike, nor indeed do they present the same relations. The *second*, *third*, *fourth*, and *fifth nerves* run inwards towards the spinous processes, superficial to the semispinalis colli muscle, and under cover of the complexus. When close to the mesial plane they turn backwards, pierce the complexus, splenius, and trapezius muscles and become superficial. In their course to the surface they give numerous twigs to the neighbouring muscles.

The internal branch of the second nerve is remarkable for its large size. It receives the special name of *great occipital.* It will be noticed turning round the lower border of the inferior oblique muscle, to which it supplies some twigs.

In passing to the surface it pierces the complexus and trapezius. To the former it gives several twigs. The distribution of this nerve on the occiput has already been noticed (p. 109).

The internal branch of the third nerve likewise sends an offset to the occipital portion of the scalp (p. 138).

The internal branches of the *lower three* posterior divisions of the cervical nerves resemble the preceding, in so far that they take a course inwards towards the spinous processes. They differ from them, however, in running under cover of the semispinalis muscle, and in being, as a rule, entirely expended in the supply of muscles.

Dorsal Region.—The posterior primary divisions of the dorsal nerves make their appearance in the intervals between the transverse processes. The *external branches* proceed outwards under cover of the middle column of the erector spinæ muscle, and appear in the interval between the longissimus dorsi on the one hand, and the ilio-costalis and accessorius on the other. The *upper six or seven* of these nerves are exhausted in the supply of the middle and outer columns of the erector spinæ, and the levatores costarum; the *lower five or six*, however, are considerably larger, and contain both motor and sensory fibres. After giving up their motor fibres to the same muscles, they become superficial, by piercing the serratus posticus inferior, and the latissimus dorsi, in a line with the angles of the ribs.[1]

The *internal branches* are also distributed differently in the upper and lower portions of the dorsal region. The *lower five or six* are very small, and end in the multifidus spinæ. The *upper six or seven* pass inwards between the multifidus and semispinalis, and after supplying the muscles between which they are situated, they are directed backwards, and become superficial. In passing towards the

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[1] The cutaneous distribution of these nerves has already been examined by the dissector of the upper limb.

surface they pierce the splenius, rhomboideus, and trapezius muscles.[1]

Lumbar Region.—The *internal branches* of the posterior divisions of the five lumbar nerves are of small size, and, like the corresponding twigs in the lower dorsal region, they have a purely muscular distribution. They end in the multifidus spinæ muscle.

The *external branches* sink into the substance of the erector spinæ, and are concerned in the supply of that muscle, and also of the lumbar intertransverse muscles. The *upper three* of these nerves are of large size, and become cutaneous by piercing the superficial lamella of the lumbar fascia. They have already been traced by the dissector of the lower limb to the skin of the gluteal region. The lowest external branch communicates with the corresponding branch of the first sacral nerve.

Blood Vessels of the Back.—In the *cervical region* the dissector has already noticed the arteria profunda cervicis, the second part of the occipital artery, and its branch termed the arteria princeps cervicis. Deep in the sub-occipital region he will subsequently meet with a small portion of the vertebral artery. In addition to these, however, minute twigs may be discovered in a well-injected subject, passing backwards from the vertebral artery, in the intervals between the transverse processes, and also in the sub-occipital space. These supply the muscles, and anastomose with the other arteries in this region.

In the *dorsal region* the *dorsal branches* of the aortic intercostal arteries make their appearance between the transverse processes. Each of these vessels reaches this point by passing backwards in the interval between the body of a vertebra and the superior costo-transverse ligament. It is associated with the corresponding posterior primary division

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[1] The cutaneous distribution of these nerves has already been examined by the dissector of the upper limb.

of a spinal nerve, and with it is distributed to the muscles and integument of the back.

In the *lumbar region* similar branches are derived from the lumbar arteries. They are distributed upon the same plan.

In both dorsal and lumbar regions these vessels, before reaching the back, furnish small *spinal branches* which enter the spinal canal through the intervertebral foramina. These will be traced at a later period.

The accompanying *veins* of the dorsal branches of the lumbar and intercostal arteries pour their blood into the lumbar and intercostal veins. These veins are of large size, being joined by tributaries from the dorsal spinal venous plexus, and also by others from the interior of the spinal canal.

Transversus Spinalis.—Under this name are included a system of muscles which occupy the vertebral groove from the back of the sacrum as high as the axis vertebra. When this muscular mass is analysed, it is found to consist of three strata, each of which is composed of a series of bundles or slips pursuing a more or less oblique course. As the term given to the whole system implies, these slips for the most part stretch from the transverse processes upwards and inwards to be inserted into the spinous processes of the vertebræ. The superficial slips pass over five or more vertebræ and connect distant points on the column; the deeper slips are shorter, and the most deeply placed of all merely pass between contiguous vertebræ.

The superficial layer is termed the *semispinalis muscle;* the intermediate layer is called the *multifidus spinæ;* whilst the deep stratum is composed of a series of short muscles, termed the *rotatores spinæ.* In the dorsal and cervical regions we find the three layers (Hughes); in the lumbar and sacral regions the semispinalis is absent.

Dissection.—The semispinalis muscle is already in great part exposed. To display it fully, however, it is necessary to remove the spinalis dorsi muscle.

The Semispinalis Muscle is described in two parts—the semispinalis dorsi and semispinalis colli.

The *semispinalis dorsi* is composed of a series of muscular slips, with long tendons at either end, which arise from the transverse processes of five of the lower dorsal vertebræ (viz., from the sixth to the tenth). It is inserted into the spines of the upper four dorsal and lower two cervical vertebræ.

The *semispinalis colli* lies under cover of the complexus. Its springs from the transverse processes of the upper five dorsal vertebræ, and is inserted into the spines of four cervical vertebræ (viz., from the second to the fifth).

The slips composing the semispinalis muscle stretch over five or more vertebræ.

Dissection.—The multifidus spinæ is of great extent. Beginning in the sacral region, it passes upwards as far as the axis vertebra. It is weakly developed in the dorsal region, but is strongly marked in the loin and in the neck—more especially in the former. To bring it thoroughly into view, the semispinalis muscle must be detached from the spines and thrown outwards: the erector spinæ muscle must also be separated from the lumbar and sacral spines and drawn aside—if, indeed, this has not been already done in following out the nerves.

Multifidus Spinæ (multifidus).—In the *lumbar* and *sacral regions*, the multifidus will be seen to constitute a thick fleshy mass, which clings closely to the vertebral spines. In this situation it has a very extensive origin—viz., (1) from the deep surface of the aponeurotic origin of the erector spinæ; (2) from the posterior surface of the sacrum as low as the fourth aperture; (3) from the posterior sacro-iliac ligament; (4) from the posterior superior spine of the ilium; and (5) from the mammillary processes of the lumbar vertebræ. In the *dorsal region* it takes origin from the transverse processes of the vertebræ, and in the *cervical region* from the articular processes of at least four of the lower cervical vertebræ. The bundles which compose the multifidus pass over two, three, or four vertebræ, and are inserted into the whole length of the various spinous processes of the movable vertebræ as high up as the axis.

The Rotatores Spinæ (submultifidus) are a series of small muscles which may be exposed by raising the multifidus. In the dorsal region each muscle springs from the root of a transverse process, and is inserted into the lamina of the vertebra immediately above, close to the root of the spinous process. Somewhat similar muscles have been described in the cervical and lumbar regions, and also a series of longer and more superficial slips which connect alternate vertebræ with each other (Hughes).

Interspinales and Intertransversales.—The dissector should next examine the minute interspinous and intertransverse muscles.

The *interspinous muscles* can hardly be said to exist in the dorsal region, except in its upper and lower part, where they are present in a rudimentary condition. In the neck they are arranged in pairs—two occupying each interspinous interval, with the exception of that between the axis and atlas. In the lumbar region they are also well marked and in pairs; here they are attached to the whole length of the spinous processes.

The *intertransverse muscles* (intertransversarii) are strongly developed in the lumbar region, and occupy the entire length of the intertransverse intervals. Additional rounded fasciculi may be observed passing between the accessory processes. These are termed the *interaccessorii.*

In the *dorsal region* intertransverse muscles—very weak and poorly developed—are only found in the lower three or four spaces.

In the *cervical region* the intertransversales are present in pairs. They will be better examined at a subsequent period.

Levatores Costarum.—These constitute a series of twelve fan-shaped muscles, which pass from the transverse processes to the ribs. To bring them thoroughly into view, the longissimus dorsi, ilio-costalis, and accessorius muscles should be removed. The first muscle of the series springs

from the tip of the transverse process of the last cervical vertebra, and, expanding as it proceeds downwards and outwards, is inserted into the outer border of the first rib, immediately beyond the tubercle. Each of the succeeding muscles takes origin from the tip of a dorsal transverse process, and is inserted into the outer surface of the rib immediately below, along a line extending from the tubercle to the angle.

Posterior Primary Divisions of the Sacral Nerves.—These are very small. The *upper four* will be found emerging from the posterior sacral foramina ; *the fifth* appears at the lower end of the sacral canal.

To expose the *upper three* the multifidus spinæ muscle covering the upper three sacral apertures must be carefully removed. Each of these three nerves will be found to divide in the usual manner into an internal and external branch.

The *internal branches* are very fine, and end in the multifidus spinæ.

The *external branches* are somewhat larger, and join together so as to form a looped plexus upon the back of the sacrum. This communicates above with the external branch of the last lumbar nerve and below with the posterior division of the fourth sacral nerve. Branches proceed from the loops thus formed to the surface of the great sacro-sciatic ligament. Finally they become superficial by piercing the gluteus maximus muscle, and they supply a limited area of skin over the gluteal region. They have already been examined by the dissector of the lower limb.

The *lowest two* posterior primary divisions of the sacral nerves do not exhibit the usual division into external and internal branches. They are very small, and, after communicating with each other, and also with the *coccygeal nerve*, they distribute filaments to the parts on the back of the lower portion of the sacrum and on the dorsal aspect of the coccyx.

Minute twigs from the lateral sacral artery accompany the sacral nerves and anastomose with twigs from the gluteal and sciatic arteries.

The Posterior Division of the Coccygeal Nerve is a slender twig which emerges from the inferior opening of the sacral canal, and, after being joined by a filament from the last sacral nerve, is distributed on the back of the coccyx.

Dorsal Spinal Venous Plexus.—A plexus of veins is situated upon the superficial aspect of the neural arches of the vertebræ, subjacent to the multifidus muscle. This plexus collects blood from the integument and muscles of the back, and in the dorsal and lumbar regions pours it into the posterior tributaries of the intercostal and lumbar veins. In the neck it is especially well marked, and its blood is emptied into the vertebral veins. It is hardly to be expected, however, that the dissector, in an ordinary dissection, will make out much of these venous channels.

Directions.—The last day upon which the body is allowed to remain in its present position must be devoted to the dissection of the sub-occipital triangle, and to the display of the spinal cord, its membranes, nerve-roots, and blood vessels.

In the event of the dissector being pushed for time, it is better that he should proceed at once to expose the spinal cord, and defer the dissection of the sub-occipital region until the head and neck has been removed from the body.

The Sub-Occipital Space is a small triangular area, exposed by the reflection of the complexus muscle. It is *bounded* by three muscles—viz. (1) the rectus capitis posticus major, which forms its upper and inner boundary; (2) the obliquus inferior, which limits it below; and (3) the obliquus superior, which bounds it above and to the outer side. When dissected, *its floor* will be found to consist of two structures—viz., the posterior arch of the atlas and the thin posterior occipito-atlantal ligament. It *contains* within its area a portion of the vertebral artery and the

posterior primary division of the sub-occipital or first cervical nerve.

Dissection.—Before cleaning the muscles bounding the triangle, the sub-occipital nerve must be secured. This can best be done by tracing into the space the minute twig which it has been seen to give to the deep surface of the complexus, or, if this has not been observed, by endeavouring to find the twig which it gives to the rectus capitis posticus major. The tissue in which the nerve lies is very dense, and the dissection in consequence is rendered somewhat difficult.

The Rectus Capitis Posticus Major springs by a pointed origin from the spine of the axis, and, expanding as it passes upwards and outwards, it is inserted into the occipital bone along the outer portion of the inferior curved line and the surface immediately below.

The Rectus Capitis Posticus Minor is a minute fan-shaped muscle, placed to the inner side and upon a deeper plane than the preceding muscle. It takes origin from the tubercle on the posterior arch of the atlas, and is inserted into the inner part of the inferior curved line of the occipital bone and the surface between this and the foramen magnum.

The Obliquus Capitis Inferior stretches from the bifid spine of the axis, from the extremity of which it takes origin, to the posterior tubercle of the transverse process of the atlas. The great occipital nerve will be seen hooking round its lower border.

The Obliquus Capitis Superior springs from the transverse process of the atlas, and is inserted into the occipital bone in the interval between the curved lines.

The Posterior Division of the Sub-Occipital Nerve does not divide into an external and internal branch. It enters the sub-occipital triangle by passing backwards between the posterior arch of the atlas and the vertebral artery; so that even in cases where all its branches have been divided, the trunk is readily found in this position. The nerve at once breaks up into branches which go to supply five

muscles—viz., the two recti, the two oblique muscles, and the complexus. In addition to these muscular twigs it gives a *communicating*, and sometimes a *cutaneous filament.*

The *communicating branch* generally proceeds from the nerve to the obliquus capitis inferior, and joins the great occipital nerve. The *cutaneous branch* when present accompanies the occipital artery to the integument over the occiput.

Vertebral Artery.—It is only a small portion of this vessel which occupies the sub-occipital triangle. Emerging from the foramen in the transverse process of the atlas, it runs backwards and inwards in the groove upon the posterior arch of the same bone. In this course it crosses the sub-occipital nerve, and lies immediately behind the lateral mass of the atlas. It leaves the space and enters the cranial cavity through the foramen magnum by turning forwards below the posterior occipito-atlantal ligament and piercing the dura mater.

Small branches proceed from the vertebral artery in this situation to supply the parts in its immediate neighbourhood, and to anastomose with the arteria princeps cervicis and the arteria profunda cervicis.

Dissection to open the Spinal Canal.—The first step consists in thoroughly cleaning the vertebral laminæ and spinous processes upon either side. The multifidus spinæ must also be completely removed from the back of the sacrum. At the same time the posterior primary divisions must be retained, so that their continuity with the various spinal nerve-trunks may be afterwards established. The posterior wall of the spinal canal should now be removed *in one piece* by sawing through the laminæ of the vertebræ on either side, and dividing the ligamenta subflava, from the third cervical vertebra down to the lower opening of the canal on the back of the sacrum.

In making this dissection the student must attend to the following points :—(1) the cut should be directed through the laminæ close to the inner side of the articular processes ; (2) the saw must be used in an oblique plane, so that the cut through the laminæ slants slightly inwards ; (3) in cutting through the cervical laminæ the head and neck

should hang over the end of the table, and be pressed as far forwards as possible whilst the saw is worked from below upwards ; (4) in the case of the lumbar region, where, indeed, most difficulty will be met, a high block must be placed under the abdomen of the subject, whilst the blocks supporting the chest and pelvis are removed. It will probably be necessary at this point to have recourse to the hammer and chisel.

The laminæ and spinous processes which are thus removed are connected with each other by the ligamenta subflava and the supraspinous and interspinous ligaments. They should, therefore, be laid aside for the present. A description of these ligaments will be found farther on. When the specimen is fresh, however, the dissector should note the high elasticity of the ligamenta subflava. This can be tested by stretching the specimen.

Between the dura mater and the walls of the spinal canal, the dissector will notice a quantity of loose areolar tissue and soft fat. The latter is especially plentiful in the sacral region, where it resembles somewhat the marrow which occupies the medullary cavity of a long bone. In the midst of this areolo-fatty material, great numbers of large veins and minute arteries are found ramifying upon the walls of the canal.

Spinal Arteries.—A minute spinal artery in a well-injected subject will be seen entering the spinal canal through each intervertebral foramen. These arteries are derived from different sources in the different regions of the spine. In the cervical region they come from the vertebral artery ; in the dorsal region from the dorsal branches of the intercostal arteries ; in the lumbar region from the dorsal branches of the lumbar arteries. They supply with blood the spinal cord and its meninges, the bones, the periosteum, and the ligaments ; and their arrangement is very much the same in the three regions.

Each spinal artery may be looked upon as giving off *three main twigs :* of these *one*, a very small branch, ramifies upon the deep surface of the neural arches and ligamenta subflava ; *another* can be followed to the dura mater, which it pierces immediately above the point of exit of the corresponding spinal nerve ; whilst *the third* is carried inwards in front of the dura mater towards the posterior surface of the vertebral bodies. Each of the last-mentioned branches divides

into an ascending and descending twig. These anastomose with the corresponding twigs of the arteries above and below, and in this manner a continuous series of minute arterial arcades is formed. From these arcades, branches pass inwards upon the posterior aspect of the vertebral bodies, and join a small median longitudinal artery which extends along the anterior wall of the spinal canal.

In the *cervical region* small branches from the ascending cervical artery also find their way into the spinal canal; whilst in the *sacral* portion of the canal, the dissector will find branches from the lateral sacral arteries.

Intraspinal Veins.—These, sometimes termed the *rachidian veins*, are very large and very complicated in their arrangement. They may be considered to form a posterior and an anterior intraspinal plexus.

The *posterior intraspinal venous plexus* consists of two main longitudinal vessels, united by many cross branches, which run along the deep aspect of the neural arches and ligamenta subflava. Above, they communicate with the occipital sinus, whilst all the way down they are connected with the *dorsal spinal venous plexus* by wide channels which pierce the ligamenta subflava. Laterally they send branches through the intervertebral foramina to join the posterior branches of the intercostal and lumbar veins.

The *anterior intraspinal venous plexus* cannot be dissected whilst the spinal cord and its membranes are *in situ*, but it will be more convenient to describe it at this stage. Indeed, the dissection is one of considerable difficulty, even under the most advantageous circumstances. Like the preceding, it is composed of two longitudinal venous channels placed one upon either side of the posterior common ligament of the vertebral bodies, and joined by numerous transverse branches which cross the mesial plane under cover of this ligament. These transverse veins receive large tributaries from the interior of the vertebral bodies.

Superiorly each of the main longitudinal channels communicates with the occipital and basilar sinuses within the cranium, and gives off a branch which emerges above the neural arch of the atlas to form the commencement of the vertebral vein. Opposite the various intervertebral discs they send off branches which run towards the intervertebral foramina, and, joining the corresponding branches of the posterior intraspinal plexus, form a plexus around the corresponding spinal nerve.

Meninges of the Spinal Cord—Fig. 200.—The spinal cord, like the brain, with which it is continuous, is enveloped by three membranes termed *meninges.* The most external investment is a strong fibrous membrane called the *dura mater;* the second, in order from without inwards, is a non-vascular tunic termed the *arachnoid mater;* whilst the third and most internal is the *pia mater.* These membranes are directly continuous with the corresponding investments of the brain.

Dissection.—The outer surface of the dura mater must now be cleaned. This is effected by removing from the spinal canal the loose areolar tissue, soft fat, and posterior intraspinal veins. It is necessary, also, to carefully define the numerous lateral prolongations which the membrane gives to the spinal nerves.

Dura Mater Spinalis—Fig. 200 (*d*).—In the spinal canal the dura mater constitutes an exceedingly dense and tough fibrous tube, which extends from the foramen magnum above, to the level of the second or third piece of the sacrum below. Even before this tube of membrane is laid open, the dissector can readily satisfy himself that it is very loosely adapted to the spinal cord and the nerve-roots which form the cauda equina; in other words, it is very capacious in comparison with the volume of its contents. Its calibre, moreover, is by no means uniform; in the cervical and lumbar regions it is considerably wider than in the dorsal region, whilst in the sacral canal it rapidly contracts and

finally ends by blending with the filum terminale, a fibrous thread which is prolonged downwards through the sacral canal from the extremity of the spinal cord. *Above*, the dura mater is firmly attached to the third cervical vertebra, to the axis vertebra, and around the margin of the occipital foramen ; *below*, the filum terminale, on which it terminates, can be traced as far as the dorsal aspect of the coccyx, where it is lost by blending with the periosteum investing that bone.

If the student recall the characteristics of the cranial dura mater, he cannot fail to observe certain striking points of difference between it and the spinal dura mater. The relations which the latter presents to the walls of the spinal canal are altogether different. Within the cranial cavity the dura mater is closely adherent to the bones, and forms for them an internal periosteum. As it is traced into the spinal canal it will be found to split at the foramen magnum into its two constituent layers. The inner of these two laminæ is carried downwards as the long cylindrical tube which encloses the spinal cord. The outer lamina, which is very much thinner, becomes continuous, behind and on each side of the foramen magnum, with the periosteum on the exterior of the cranium, whilst in front, it is prolonged downwards into the vertebral canal in connection with the ligaments and periosteum on the anterior wall of the canal. The spinal dura mater corresponds, therefore, to the supporting layer of the cranial dura mater and to it alone. It is separated from the walls of the spinal canal and its lining periosteum by an interval or space, which is filled by loose fat, areolar tissue, and the intra-spinal plexuses of veins. In connection with the spinal dura mater there are no venous sinuses such as are present in the cranial cavity, but it should be noted that the intra-spinal veins, placed between the periosteum of the spinal canal and the tube of dura mater, occupy the same morphological plane as the cranial sinuses. Another feature which serves to distinguish the spinal dura mater from the

cranial dura mater consists in the fact that it gives off from its deep surface no partitions or septa.

The cylindrical tube of spinal dura mater does not lie free within the vertebral canal, although its attachments are of such a nature that they do not in any way interfere with the free movement of the vertebral column. On either side the spinal nerve roots, as they pierce the dura mater, carry with them into the intervertebral foramina tubular sheaths of the membrane, whilst in front loose fibrous prolongations—more numerous above and below than in the dorsal region—connect the tube of dura mater to the posterior common ligament of the vertebral column. No connection of any kind exists between the dura mater and the neural arches of the vertebræ or ligamenta subflava.

Dissection.—The tube of dura mater may now be opened with the scissors. The incision should be carried through the membrane in the mesial plane. Care, however, must be taken not to injure the delicate arachnoid, which is subjacent.

Subdural Space.—The capillary interval between the dura mater and the arachnoid mater is termed the *subdural space*—Fig. 200 (*sd*). The deep surface of the dura, which is turned towards this space, is smooth, moist, and polished. Upon either side the dissector will notice the series of apertures of exit for the roots of the spinal nerves. These are ranged in pairs opposite each intervertebral foramen, and the subdural space is prolonged outwards for a short distance upon each of the nerve-roots.

Viewed from the inside of the tube of dura mater, each of the two nerve-roots belonging to a spinal nerve is seen to carry with it a special and distinct sheath. When examined, however, on the outside of the tube of dura mater, the appearance is such that the dissector might be led to conclude that both roots are enveloped in one sheath. This is due to the fact that the two sheaths are closely held together on the outside by intervening connective tissue, which can be removed with a little careful dissection. When this is done, the two tubular sheaths will be observed to remain distinct as far as the ganglion on the posterior root of the nerve. At this point they blend with each other.

Arachnoidea Spinalis—Fig. 200 (*a*).—The arachnoid resembles the dura mater in forming a loose, wide investment for the spinal cord. Unlike the dura, however, it is remarkable for its great delicacy and transparency. The sac which it forms is most capacious towards its lower part, where it envelops the extremity of the cord and the collection of long nerve-roots which constitute the *cauda equina*. Here it can be most easily demonstrated by making an incision into it, and inserting the handle of the scalpel, or, better still, by inflating the sac with air by means of a blow-

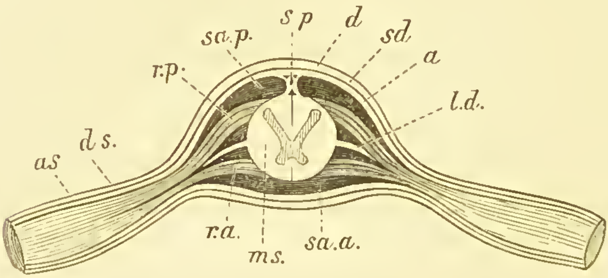

FIG. 200.—Transverse section through the spinal cord and its membranes. (SCHWALBE, after KEY and RETZIUS.)

ld. Ligamentum denticulatum.
a. Arachnoid mater.
sd. Subdural space.
d. Dura mater.
sp. Septum posticum.
sa.p. Sub-arachnoid space behind.
rp. Posterior nerve-root.
ds. Sheath of dura mater.
as. Sheath of arachnoid mater.
ra. Anterior nerve-root.
ms. Spinal cord.
sa.a. Sub-arachnoid space in front.

pipe. Above, the arachnoid mater becomes continuous at the level of the foramen magnum with the corresponding membrane which clothes the brain, whilst, laterally, it is prolonged outwards upon the various nerve-roots, thus contributing to each a tubular sheath.

Sub-arachnoid Space.—Fig. 200 (*sa.p.*).—This term is applied to the wide space between the arachnoid and pia mater. It is occupied by a variable amount of cerebro-spinal fluid, and is directly continuous with the cranial sub-arachnoid

space. Three incomplete septa partially subdivide the spinal sub-arachnoid space into compartments. One of these septa is a mesial partition called the *septum posticum*, which connects the pia mater covering the posterior aspect of the cord with the arachnoid mater. In the upper part of the cervical region the septum posticum is very imperfect, and is simply represented by a number of strands passing between the two membranes; in the lower part of the cervical region and in the dorsal region it becomes tolerably complete. The other two septa are formed by the ligamenta denticulata. These spread outwards from each side of the spinal cord, and will be studied with the pia mater.

Dissection.—Clear away the arachnoid mater from a portion of the cord, and proceed to the study of the pia mater.

Pia Mater Spinalis.—This is a firm vascular membrane, which closely invests and is firmly adherent to the surface of the spinal cord. In front, it sends a fold into the antero-median fissure of the spinal cord, whilst behind a septum continuous with its deep surface dips into the postero-median fissure. Anteriorly, in the mesial plane, it is thickened in the form of a longitudinal glistening band, which receives the name of the *linea splendens*. Of course this can only be seen after the cord has been removed from the spinal canal.

The Ligamentum Denticulatum—Fig. 201 (3)—is a very remarkable fibrous band, which stretches outwards from either side of the pia mater, so as to connect it with the dura mater. Its *pial* or *inner attachment* extends in a continuous line between the anterior and posterior nerve-roots, from the level of foramen magnum above to the level of the body of the first lumbar vertebra below. Its *outer margin* is widely serrated or denticulated. From twenty to twenty-two denticulations may be recognised. They occur in the intervals between the spinal nerves, and, pushing the arachnoid before them, they are attached by their pointed extremities to the inner surface of the dura mater.

The ligamenta denticulata partially subdivide the subarachnoid space into an anterior and a posterior compartment. In the anterior compartment the anterior nerve-roots pass outwards; the posterior compartment contains the posterior nerve-roots, and is imperfectly subdivided into two lateral subdivisions by the septum posticum.

By means of the ligamentum denticulatum of either side, the spinal cord is suspended in the middle of the sac of dura mater.

Spinal Cord.—The spinal cord itself may now be studied *in situ*. It is a cylindrical structure, slightly flattened in front and behind, which extends from the margin of the foramen magnum, where it is continuous with the medulla oblongata of the brain, to the lower border of the body of the first or the upper border of the body of the second lumbar vertebra. Its lower end rapidly tapers to a point, and is termed the *conus medullaris*. From the extremity of this, a slender filament, termed the *filum terminale* or *central ligament*, is prolonged downwards.

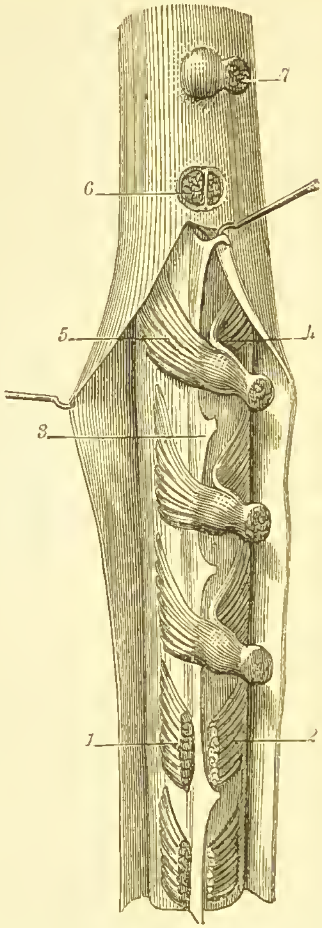

FIG. 201.—Lateral view of the spinal cord, dura mater, and ligamentum denticulatum. —(HIRSCHFELD and LEVEILLE.)

1 and 2. Fasciculi of origin of nerve-roots.
3. Ligamentum denticulatum.
4. Anterior nerve root.
5. Posterior nerve root.
6. Section through nerve roots.
7. Spinal nerve with its sheath of dura mater.

In the female the average length of the spinal cord is sixteen and a quarter inches; in the male it is seventeen and a half inches.

Throughout the greater part of the dorsal region the spinal cord presents a uniform girth, but in the cervical and lower dorsal regions it shows marked swellings, termed respectively the *cervical* and *lumbar enlargements*. From these expansions proceed the nerves which supply the upper and lower limbs. The *cervical swelling* (intumescentia cervicalis) is the more evident of the two. It begins at the upper end of the cord and attains its greatest breadth (13 to 14 mm.) opposite the fifth or sixth cervical vertebra. Below it subsides opposite the second dorsal vertebra. The *lumbar swelling* (intumescentia lumbalis) begins at the level of the tenth dorsal vertebra, and attains its maximum transverse diameter (11 to 13 mm.) opposite the last dorsal vertebra. Below it rapidly tapers into the tapering conus medullaris.

Filum Terminale.—This delicate thread-like filament lies amidst the numerous long nerve-roots which occupy the lower part of the spinal canal, and it can readily be detected from these (1) by its silvery glistening appearance, and (2) by its continuity with the extremity of the *conus medullaris*.

Although the central canal of the spinal cord is prolonged down in its interior for nearly half its length, and nervous elements can be traced in its substance for a like distance, the filum terminale is chiefly composed of pia mater carried downwards from the conus medullaris. The *linea splendens* and the lower ends of the *ligamenta denticulata* may also be considered to be continued into it. At the level of the second or third sacral vertebra it pierces the tapered end of the tube of dura mater, and receives an investment from it, and, finally, reaching the lower end of the sacral canal, it terminates by blending with the periosteum on the back of the coccyx or last piece of the sacrum.

In length the filum terminale measures about six inches. The part within the tube of dura mater is termed the *filum terminale internum*, the portion outside is distinguished as the *filum terminale externum*.

Spinal Nerves.—Thirty-one spinal nerves take origin from each side of the spinal cord. These are classified into five groups, according to the vertebræ with which they are associated. The dorsal, lumbar, and sacral nerves correspond in number with the number of vertebræ in each of these regions,—thus, there are twelve dorsal, five lumbar, and five sacral nerves, each of which issues from the spinal canal below the vertebra with which it numerically corresponds. In the cervical region, however, there are eight nerves, the first of which comes out between the occiput and the atlas, and is therefore distinguished by the special name of the *sub-occipital nerve*. There is only one coccygeal nerve on each side.

Spinal Nerve-Roots—(Fig. 202).—Each spinal nerve springs from the side of the spinal cord by *two roots*—an *anterior* and a *posterior*. Except in the case of the sub-occipital nerve (where, indeed, the posterior root is sometimes absent), the posterior nerve-root is the larger of the two. In addition to this, the posterior root is distinguished by possessing an oval ganglion, termed the *spinal root-ganglion*. There is, likewise, a wide physiological difference between the two roots,—the posterior root is composed of sensory fibres, the anterior root consists of motor fibres. Immediately beyond the ganglion the two roots unite to form the *spinal nerve-trunk*, which, in consequence, contains a mixture of both motor and sensory nerve-fibres.

The *mode of attachment* of the two nerve-roots to the side of the spinal cord is somewhat different in the two cases. In each instance they are attached to the cord by several separate fasciculi. In the case of the posterior root these enter the cord consecutively along a continuous straight line and at the bottom of a slight furrow. The fasciculi of

the anterior root, on the other hand, are not so regularly placed. They emerge from the cord over an area of some breadth.

The *size* of the nerve-roots will be observed to differ greatly. The lower lumbar and upper sacral nerve-roots are much the largest, whilst the lower sacral and the coceygeal roots are the smallest. In the cervical region the roots increase in size from above downwards, but more rapidly in the lower members of the group; in the dorsal region the roots of the first nerve are large, but those which succeed it are small and of uniform size.

In *relative length*, and in the *direction* which they follow

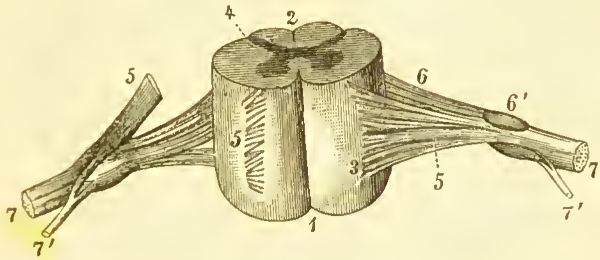

FIG. 202.—Segments of spinal cord; anterior aspect. (SCHWALBE, after ALLEN THOMSON.)

1. Anterior median fissure.
2. Posterior median fissure.
3 and 5. Fasciculi of anterior nerve-root.
4. Postero-lateral groove.
6. Posterior nerve-root.
6'. Spinal ganglion.
7. Anterior primary division.
7'. Posterior primary division.

in the spinal canal, the nerve-roots also show great differences. This is due to the spinal eord being so much shorter than the canal in which it lies. In the upper part of the cervical region the nerve-roots are short, and proceed outwards in a more or less horizontal direetion. Below this the nerve-roots gradually lengthen, and have to deseend in the spinal eanal for a distanee which is always inereasing the farther down we go. The arrangement of the lower dorsal, the lumbar, saeral and coecygeal nerve-roots, is particularly charaeteristie. They are exceedingly long, and

descend vertically from the lower portion of the cord, in the form of a bunch or leash which, from its appearance, has very fitly been termed the *cauda equina*.

Mode of Exit of Spinal Nerves from Spinal Canal.—The six lower cervical nerves, the dorsal nerves, and the

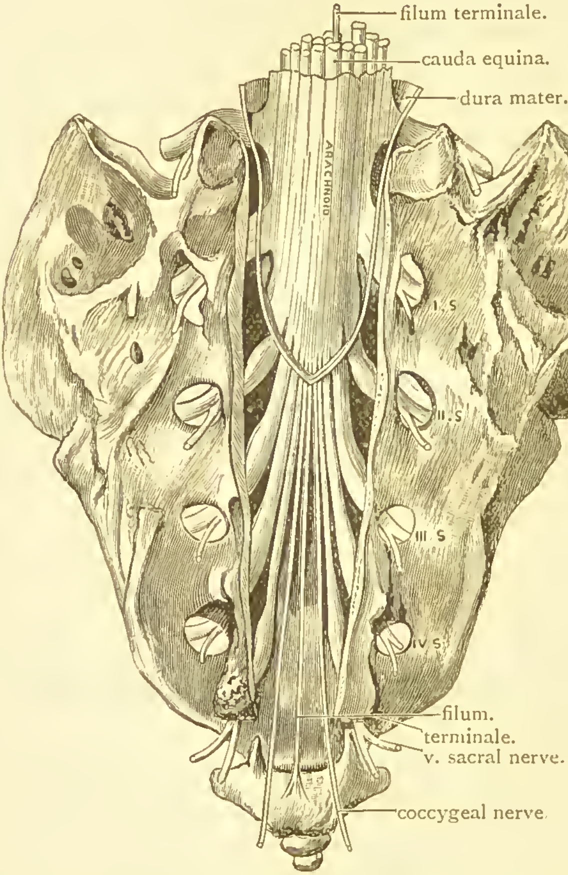

FIG. 203.—Sacral canal opened up from behind to show the sacral nerve roots (lower part of cauda equina) and the membranes in relation to them. (After TESTUT.)

lumbar nerves, make their exit through the intervertebral foramina; whilst the upper four sacral nerves find their way out by the sacral foramina. The two upper cervical

nerves, the fifth sacral nerve, and the coccygeal nerve, however, follow a different course. The sub-occipital emerges by passing over the neural arch of the atlas, and the second cervical nerve by passing over the neural arch of the axis. The fifth sacral and the coccygeal nerve leave the sacral canal through its lower aperture (Fig. 203).

Dissection.—The nerve roots of one or two spinal nerves in each region should be followed into the corresponding intervertebral foramina. This can be easily done by snipping away the articular processes with the bone-pliers. The position of the ganglion on the posterior root, the connections of the sheath of dura mater, the union of the two roots to form the spinal nerve-trunk, and the division of the latter into the anterior and posterior primary divisions, can thus be studied. An attempt should also be made at the same time to discover the minute *sinu-vertebral nerve* of Luschka. This is a fine twig which is formed by the union of a small filament from the spinal nerve trunk with a minute branch from the sympathetic cord. It takes a recurrent course through the intervertebral foramen to end in the bones and periosteum of the vertebral canal.

The Spinal Root-Ganglia.—These ganglia are oval swellings developed upon the posterior nerve roots, just before they unite with the anterior roots to form the spinal nerve trunks. They are usually found upon the posterior roots of all the nerves, although occasionally the ganglion may be absent in the case of the sub-occipital nerve.

Except in the case of the two upper cervical nerves, and the sacral and coccygeal nerves, the spinal ganglia are formed upon the posterior nerve roots as they lie in the intervertebral foramina. The ganglia of the first two cervical nerves lie upon the neural arches of the first and second cervical vertebræ respectively ; the ganglia of the sacral and coccygeal nerves are placed within the sacral canal, but outside the tube of dura mater. Sometimes the ganglion on the posterior root of the coccygeal nerve will be found inside the tube of dura mater.

Spinal Nerve Trunks.—These are formed by the union of the anterior and posterior nerve roots immediately

beyond the spinal ganglia, and from what has been said it must be evident that this union takes place in the case of the coccygeal and sacral nerves in the sacral canal; in the lumbar, dorsal, and lower six cervical nerves in the intervertebral foramina; and in the case of first two cervical nerves on the neural arches of the atlas and axis.

The nerve trunk is exceedingly short; indeed, it is almost no sooner formed than it divides into its *anterior and posterior primary divisions.* In the case of the sacral and coccygeal nerves, this subdivision takes place in the sacral canal, and the spinal nerve trunks of these nerves are distinctly longer than in the case of the nerves which occupy a higher level.

The distribution of the posterior primary divisions has already been examined (p. 154).

Dissection.—At this stage the dissector may adopt one of two methods in the further treatment of the cord and the nerves which spring from it. If the cord is fresh and in such a condition that it may be successfully hardened, it is best to transfer it at once to the preservative fluid. If, on the other hand, it is soft and not fit for proper preservation (and it must be admitted that this is generally the condition in which the spinal cord is found in the dissecting room), it should be removed with all its membranes and nerve roots, and placed in a cork-lined tray filled with water. There is no method by which the arachnoid, the pia mater, the ligamenta denticulata, and the nerve-roots can be so well studied as this.

In removing the spinal cord, the spinal nerves should be divided as they lie in the intervertebral foramina, and in such a manner that as long a piece as possible of each nerve remains attached to the dura mater and the cord. Wherever it is possible the ganglia should be taken with the nerves. The same rule also applies to the sacral nerves. The cord and its membranes should then be cut across at the highest limit of the vertebral dissection. By pulling upon the dura mater the whole specimen may now be lifted from the vertebral canal and transferred to the water-bath. The dura mater should then be slit down the mesial plane over the front of the cord, and the edges of each lateral piece drawn outwards. By fixing the dura mater to the cork at the bottom of the tray with pins the further dissection can be conducted with great advantage.

Arteries of the Spinal Cord.—It is only in cases where a paint injection has been used that the spinal arteries can be made out satisfactorily.

A large number of small arteries are supplied to the spinal cord. These are the *anterior and posterior spinal arteries* which spring from the vertebral, and a series of *lateral spinal arteries* which reach the side of the spinal cord and are derived from different sources in each region. *In the neck* they come from the spinal branches of the vertebral, ascending cervical, and deep cervical arteries; and in *the dorsal and lumbar regions* from the spinal twigs of the dorsal branches of the intercostal and lumbar arteries. By the anastomoses of these arterial twigs, five longitudinal trunks are formed upon the surface of the spinal cord. One of these occupies the mesial plane in front, and may be termed *the antero-median artery*. The other four are placed in relation to the sulci along which the posterior nerve-roots enter the cord. One runs downwards in front of the line of entrance of these roots, and the other behind it on each side of the cord. These slender arterial trunks may therefore be termed the *postero-lateral longitudinal vessels*.

The *antero-median vessel* is formed in its upper part by the union of the two anterior spinal branches of the vertebral arteries. One of these is larger than the other, and takes a much greater share in the formation of the median trunk. Below the level of the fifth pair of cervical nerves the continuity of the median vessel depends upon the reinforcements which it obtains from the lateral spinal vessels. The number of lateral spinal arteries which join the median vessel is very variable. The majority of these arteries end on the nerve roots; five to ten only reach the median vessel. The *antero-median artery* runs downwards, under cover of the linea splendens of the pia mater. Its calibre is uniform throughout, and where the cord ends it proceeds onwards for some distance upon the filum terminale.

The *postero-lateral arteries* on each side of the cord are formed in the upper part of the cervical region by the bifurcation of the corresponding posterior spinal branch of the vertebral artery. Lower down their continuity is maintained by twigs which reach them on the posterior

roots of the spinal nerves from the lateral spinal arteries. It may be regarded, as a rule, that where a lateral spinal artery gives a branch to one of the postero-lateral arterial trunks, it does not furnish another to the antero-median arterial trunk. In this way different lateral spinal arteries are in connection with the longitudinal trunks on the anterior and posterior aspects of the cord. The postero-lateral vessels end at the lower extremity of the cord.

From the five main arterial channels which thus extend along the cord numerous anastomosing twigs ramify in the pia mater.

Veins of the Spinal Cord.—These veins are small and numerous, and their disposition cannot be said to correspond with that of the arteries. They are very tortuous, and form a plexus with elongated meshes. Four more or less perfect longitudinal venous trunks may be noticed on the surface of the cord in connection with this plexus. Two of these are mesial, and are placed respectively on the anterior and posterior aspects of the cord. The anterior trunk runs upwards under cover of the antero-median spinal artery. The other two are lateral, and are situated one on either side of the cord in relation to the anterior nerve roots.

Upon either side, the veins of the spinal cord effect communications with the veins in the spinal canal by means of small twigs which run outwards on the nerve roots.

How to distinguish the anterior from the posterior surface of the spinal cord.

Anterior Surface.	Posterior Surface.
1. Linea splendens.	1. The postero-lateral arteries in relation to the posterior nerve-roots.
2. Single anterior spinal artery in mesial plane.	2. Fasciculi of origin of posterior nerve-roots entering the cord along a straight and continuous line, and at the bottom of a distinct sulcus.
3. Anterior nerve-roots smaller than posterior, and springing by fasciculi which emerge from the cord, not in a continuous straight line, but irregularly over an area of some width.	3. Posterior nerve-roots larger than the anterior, and provided with ganglia.

Preservation of the Spinal Cord.—If the spinal cord be in a fit state for preservation, the dissector should immerse it for a few weeks in methylated spirit, or in a large quantity of a saturated solution of bichromate of potash. When sufficiently firm, the dissector should endeavour to learn something of its internal structure by making transverse sections through it at different levels, and inspecting the cut surface closely with the naked eye, or with the aid of a magnifying glass.

Internal Structure of the Spinal Cord.—A good deal can be learned by a naked eye inspection of cross sections of the cord made in different regions and at different levels.

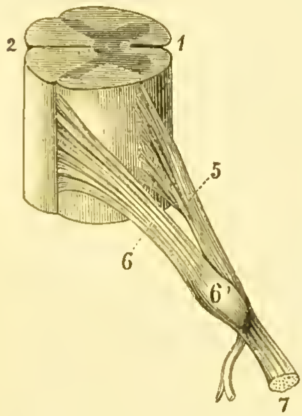

FIG. 204.—Segment of spinal cord; lateral aspect. (SCHWALBE, after ALLEN THOMSON.)

1. Anterior median fissure.
2. Posterior median fissure.
5. Fasciculi of anterior nerve-root.
6. Posterior nerve-root.
6′. Spinal ganglion.
7. Anterior primary division.

The spinal cord is then seen to be a bilateral structure. It is partially subdivided into a right and a left half by two median clefts,—one upon the anterior, and the other upon the posterior aspect. These clefts are called the *antero-median* and the *postero-median fissures*, and they extend along the entire length of the cord.

At the same time, it must be noted that these two median fissures present many points of difference. The antero-median fissure is, for the greater part of its length, much shallower than the postero-median fissure; further, it is wider and much more apparent, and the pia mater dips down into it to form a fold or reduplication within it. The postero-median cleft, in addition to its being deeper and narrower, contains only a single septum of pia mater prolonged into it from the deep surface of the enclosing membrane.

The two halves of the cord thus marked off from each other are to all intents and purposes symmetrical, and they

are joined by a more or less broad band or commissure which intervenes between the two median fissures.

An inspection of the surface of each lateral half of the cord brings into view a groove or furrow at some little distance from the postero-median furrow. Along the bottom of this groove the fasciculi of the posterior nerve roots enter the cord in accurate linear order. It is called the *postero-lateral sulcus.* There is no corresponding furrow on the fore part of each lateral half of the cord in connection with the emergence of the fasciculi of the anterior nerve roots. As we have already observed, these fascicles emerge over a broad area, which corresponds in its width to the thickness of the subjacent extremity of the anterior horn of grey matter.

By means of the postero-lateral sulcus and line of entrance of the fascicles of the posterior nerve roots on the one hand, and the emergence of the fascicles of the anterior nerve roots on the other hand, the surface of each lateral half of the cord is subdivided into three columns, which are respectively termed posterior, lateral, and anterior. The *posterior column* is placed between the postero-median fissure and the postero-lateral furrow; the *lateral column* lies between the postero-lateral furrow and the outermost of the fascicles of the anterior nerve roots as they emerge from the cord; the *anterior column* includes that district which extends from the antero-median fissure to the emergence of the outermost of the anterior nerve-root fascicles.

The spinal cord is composed of an inside core of grey matter which is surrounded on all sides by an external coating of white matter.

Grey Matter of the Spinal Cord.—The grey matter in the interior of the spinal cord has the form of a fluted column. When seen in transverse section, it presents the shape of the letter H. In each lateral half of the spinal cord there is a crescentic mass shaped somewhat like a comma (,), the concavity of which is directed out-

wards, and the convexity inwards. The two crescents of opposite sides are connected across the middle line by a transverse band, which is called the *grey commissure.* The postero-median fissure cuts through the cord until it reaches the grey commissure. The bottom of the antero-median fissure is separated from it by an intervening strip of white matter which is termed the *anterior white commissure.* In

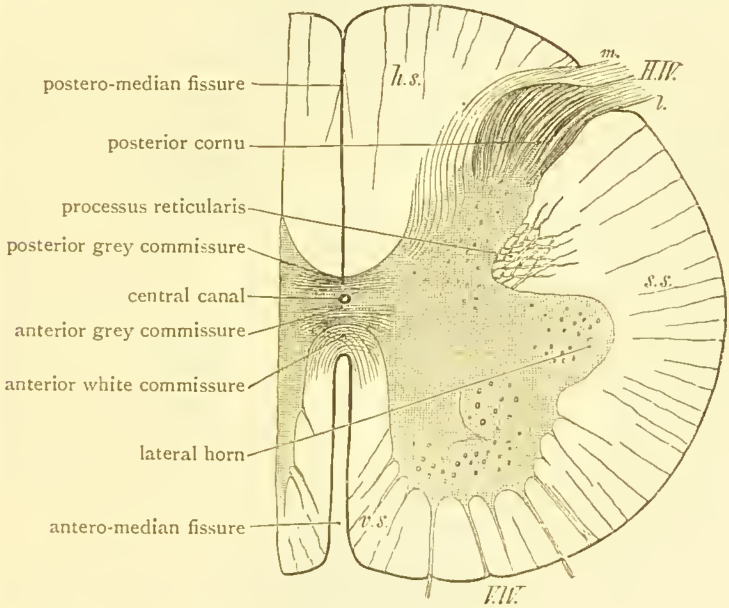

FIG. 205.—Cross section of the dorsal part of the spinal cord. (From GEGENBAUR.)

h.s. Posterior column.
s.s. Lateral column.
v.s. Anterior column.

H.W. Posterior nerve root.
V.W. Anterior nerve root.

the grey commissure may be seen the central canal of the cord. It is just visible to the naked eye as a minute speck. This canal tunnels the entire length of the cord, and opens above (after having traversed the lower half of the medulla oblongata) into the fourth ventricle of the brain. The portion of the grey commissure which lies behind the central

canal is called the *posterior grey commissure;* the portion in front receives the name of *anterior grey commissure.*

In each crescentic mass of grey matter certain well defined parts may be recognised. The projecting portions which extend behind and in front of the connecting transverse grey commissure are termed respectively the *posterior* and the *anterior cornua* of grey matter. These can be distinguished from each other at a glance.

The *anterior cornu* is short, thick, and very blunt at its extremity. Further, its extremity falls short of the surface of the cord, and is separated from it by a tolerably thick coating of white matter. Through this the fascicles of the anterior nerve-roots pass on their way to the surface. The thickened end of the anterior cornu is termed the *caput cornu*, whilst the slightly constricted part close to the grey commissure is called the *cervix cornu.* The *posterior cornu* is in most localities in the cord elongated and narrow. Further, it is drawn out to a fine point which almost reaches the bottom of the postero-lateral sulcus. This pointed extremity receives the name of the *apex cornu;* the slightly swollen part which succeeds it is the *caput cornu;* whilst the slightly constricted part adjoining the grey commissure goes under the name of the *cervix cornu.*

Covering the tip of the posterior cornu there is a substance which cannot be detected by the naked eye, but which becomes very distinct when thin sections of the cord are examined by the microscope. It differs in its composition from the general mass of grey matter, and presents a semitransparent appearance. It is termed the *substantia gelatinosa of Rolando.*

Before we refer to the different appearances which are presented by the grey matter in different districts of the cord, it is well to make it perfectly clear that when we apply the terms cervical, dorsal, lumbar, sacral, &c., to different portions of the cord, we do not mean to convey the idea that we are alluding to portions of the cord in relation to the sections of the vertebral column that bear the same names. These

terms are applied to those parts of the cord to which the different groups of nerves are attached.

The grey matter is not present in equal quantity throughout the entire length of the cord. It may be regarded as a

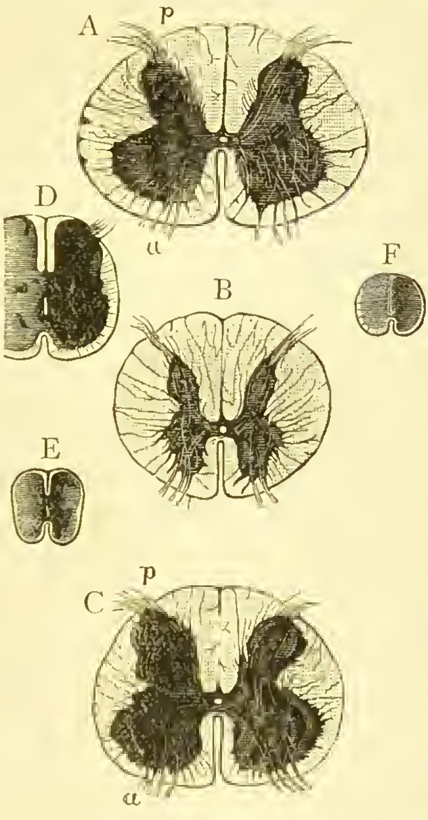

FIG. 206.—Sections through different parts of the cord. (From SCHWALBE.)

A. B. C. Enlarged twice the size of nature.
D. E. F. Enlarged three times the size of nature.

a. Anterior nerve-roots.

p. Posterior nerve-roots.

A. Section through the middle of the cervical enlargement.

B. Section through the middle of the dorsal region.

C. Section through the middle of the lumbar enlargement.

D. Section through the upper part of the conus medullaris.

E. Section at the level of the fifth sacral nerve.

F. Section at the level of the coccygeal nerve.

general law that wherever there is an increase in the bulk of the nerves attached to a particular part of the cord, that there a corresponding increase of the grey matter may be noticed. It follows from this that the districts in which the grey matter bulks most largely are the lumbar and cervical swellings. The great nerves which go to form the limb plexuses enter and pass out from those portions of the cord. In the intermediate dorsal region there is a reduction in the quantity of grey matter in correspondence with the smaller size of the dorsal nerves.

But the shape of the crescentic masses is not the same in all regions. In the dorsal region both horns are narrow, although the distinction between the anterior horn and the still more attenuated posterior horn is still sufficiently manifest. In the cervical region the contrast between the cornua is most marked; the anterior horn is very thick in comparison with the much narrower posterior horn. In the lumbar region, on the other hand, the difference in the thickness of the two horns is not nearly so apparent owing to a broadening out of the posterior horn. A section taken from the centre of each of these regions can be very readily recognised by these features.

In the dorsal region of the cord, more especially in the upper part, there is another character which is very distinctive. A pointed and prominent triangular projection juts out from the external aspect of the crescentic mass of grey matter nearly opposite the grey commissure. This is called the *lateral horn* (Figs. 205 and 206). Traced upwards into the cervical region of the cord and downwards into the lumbar region, it is seen to blend with the anterior horn, and it contributes in these districts to the thickening of that cornu. Curiously enough it again becomes evident in the sacral region of the cord.

The White Matter of the Spinal Cord.—The white matter forms a thick coating on the outside of the fluted column of grey matter. It is marked off into three columns. The

posterior column is wedge-shaped in transverse section, and lies between the postero-median fissure and the posterior cornu of grey matter. The *lateral column* occupies the concavity of the grey crescent. Behind, it is bounded by the posterior grey cornu and the postero-lateral sulcus, whilst in front it extends as far as the outermost fasciculi of the anterior nerve roots as they pass out from the anterior grey horn. The *anterior column* includes the white matter between the antero-median fissure and the anterior horn of grey matter, and also the white matter which separates the thick extremity of the anterior grey cornu from the surface of the cord. This latter portion of the anterior column is traversed by the emerging fascicles of the anterior nerve roots.

In the cervical region a faint longitudinal groove runs downwards on the surface of the posterior column of the cord. This indicates the position of a septum which passes into the column from the deep surface of the pia mater and divides it incompletely into two unequal strands. The groove is termed the *paramedian furrow*; the smaller and more internal of the two strands is called the *postero-median column* or *the tract of Goll*, whilst the outer and larger strand receives the name of the *postero-external column* or *the tract of Burdach.*

The white matter of the spinal cord increases steadily in quantity from below upwards.

SIDE OF THE NECK.

Four days having now been devoted to the dissection of the posterior aspect of the body, the subject is turned on its back, and blocks being placed under the thorax and pelvis, the dissection of the side of the neck is commenced. This region may be said to present a somewhat quadrilateral figure. *In front*, it is bounded by the middle line of the neck; *behind*, it is limited by a line corresponding to the

anterior margin of the trapezius muscle ; *below*, are the upper margin of the manubrium sterni and the prominent clavicle ; *above*, the base of the lower jaw, the mastoid process and the occiput.

Surface Anatomy.—Certain important landmarks must be recognised before the skin is reflected from the side of the neck. The sterno-mastoid muscle, pursuing a diagonal course through the space from its antero-inferior to its postero-superior angle, is, perhaps, the most essential of these. By drawing the head well over to the opposite side, it will be rendered evident. The region in front of the sterno-mastoid corresponds to the anterior triangle of the neck ; that behind it constitutes the posterior triangle. Above the notch of the manubrium sterni, and between the tendons of the two sterno-mastoid muscles, the deep suprasternal fossa will be noted. Subjacent to this fossa lies the trachea, but it is only in emaciated individuals that the rings of this tube can be felt from the surface. In its upper part the trachea is always obscured by the isthmus of the thyroid body which crosses it.

The dissector should now run his finger upwards in the middle line of the neck. Beyond the trachea the ring-like cricoid cartilage will be felt. This is a highly important landmark. With it as his guide, the surgeon is able to mark out the points at which the trachea or larynx may be opened, and also the level at which the common carotid artery is most favourably placed for the application of a ligature. Above the cricoid cartilage the finger enters the narrow interval between the cricoid and thyroid cartilages—a gap which is occupied by the tense crico-thyroid membrane. In this interval the operation of laryngotomy may be performed. Next comes the thyroid cartilage with its prominent *pomum Adami*. Beyond the thyroid cartilage is an interval occupied by the thyro-hyoid membrane, and bounded above by the hyoid bone. The body and cornua of the hyoid can be plainly felt from the surface. In the usual attitude of the

head the hyoid bone will be observed to be placed on a level with the lower margin of the mandible. Above the hyoid bone, between it and the symphysis of the lower jaw, is the anterior part of the floor of the mouth.

Dissection.—In the first instance merely the structures superficial to the deep cervical fascia should be dissected. A good-sized block being placed under the shoulders of the subject, the head is pulled backwards and the chin dragged over to the opposite side. The parts will be put still further on the stretch if the shoulder be depressed by drawing the arm downwards and then fixing it in this position.

For the reflection of the skin three incisions are required, viz.—(1) a vertical incision along the middle line of the neck, from the chin above to the sternum below; (2) a transverse cut from the lower

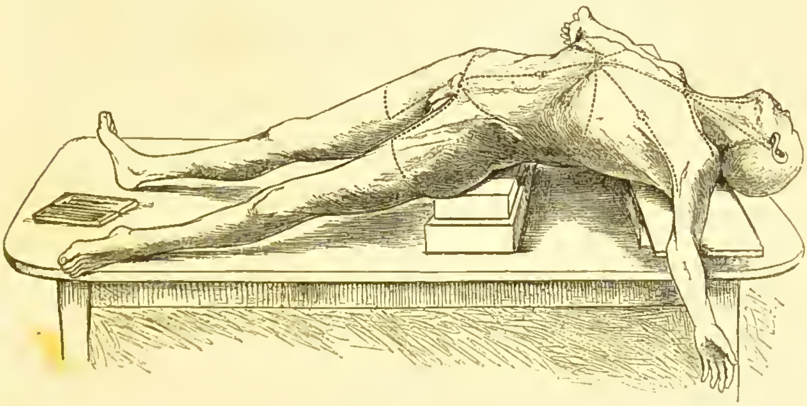

FIG. 207.

end of the mesial incision outwards along the line of the clavicle to the acromion process of the scapula; (3) an oblique incision, beginning above at the mastoid process behind the ear, and carried downwards and forwards along the anterior border of the sterno-mastoid muscle, until it meets the middle line of the neck at the top of the sternum.

Two triangular flaps of skin, corresponding in a measure to the two triangular areas of the neck, are thus mapped out, and must now be carefully raised. Throw the anterior flap upwards towards the lower jaw, and turn the posterior flap backwards towards the trapezius muscle.

Superficial Fascia.—The superficial fascia in this region contains in its midst the platysma myoides muscle—the representative in the human subject of the panniculus

carnosus in the lower animals. In the male, the adipose tissue which distinguishes the superficial fascia is generally very sparse in this locality, so that the fleshy fibres of the muscle are observed shining through it. In females and children the fat is more abundant, giving a fuller and more rounded appearance to the neck. In all cases the fatty tissue is most plentiful between the chin and hyoid bone, forming in stout individuals the so-called "double-chin."

Dissection.—The fibres of the platysma myoides muscle, which run upwards and forwards, must now be cleaned and its borders defined. In clearing the fatty tissue from its surface, minute nervous filaments will be observed piercing it to reach the skin. These are chiefly branches of the superficial cervical nerve. As the muscle extends downwards on to the front of the chest and upper part of the shoulder, it cannot be fully studied until the dissector of the arm has reflected the skin from these regions.

The Platysma Myoides is an exceedingly thin quadrilateral sheet of muscular fibres, which clothes the side and front of the neck, and lies superficial to the deep fascia. Below, it takes origin by scattered and sparse fibres from the skin and subcutaneous fascia covering the upper portions of the pectoralis major and deltoid muscles. From this it proceeds upwards and forwards over the clavicle and acromion, but obtains little or no attachment to these bones. On the side of the neck it decreases somewhat in width, and its fibres being thus more closely aggregated, it becomes thicker and more distinct. Finally, it reaches the lower jaw into the outer surface of which the majority of the fibres are inserted. The anterior fibres decussate below the chin with the corresponding fibres of the opposite muscle, whilst the posterior fibres proceed upwards into the face, and curve forwards towards the angle of the mouth where they blend with the facial muscles in this locality.

Reflection of the Platysma.—This must be done very carefully, so as not to injure the structures which lie between it and the deep fascia. These are (1) the external and anterior jugular veins; (2) the descending superficial branches of the cervical plexus, which are especially liable

to injury as they cross the clavicle and acromion process; (3) the superficial cervical nerve and infra-mandibular division of the facial nerve; and (4) the superficial lymphatic glands. The muscle should be raised from below upwards, and left attached by its facial connections.

The External Jugular Vein (vena jugularis externa)—Fig. 208 (10)—is usually a vein of some size. It will be seen emerging from the substance of the parotid gland immediately behind the angle of the lower jaw, where it is formed by the junction of the posterior auricular vein, and posterior division of the temporo-maxillary vein. From this it descends in a nearly vertical direction upon the deep cervical fascia, taking a course which may be mapped out on the surface with tolerable accuracy, by drawing a line from a point behind the angle of the jaw to the middle of the clavicle. It crosses the sterno-mastoid obliquely, and, reaching the posterior margin of this muscle, disappears from view by dipping through the deep cervical fascia immediately above the clavicle. It will subsequently be traced to its termination in the subclavian vein.

Shortly after its origin, it effects, as a general rule, a communication with the internal jugular vein, and lower down one or more superficial twigs may connect it with the anterior jugular. Half-way down the neck it is joined by a tributary of some size, which comes from the occipital region and the back of the upper part of the neck; this vein is termed the *posterior external jugular.*

Superficial Cervical Glands.—These form a group of small lymphatic glands which lie along the course of the external jugular vein. They vary from four to six in number.

The Anterior Jugular Vein (vena jugularis anterior)—Fig. 208 (23)—is small in comparison with the preceding. Sometimes, however, it exceeds it in calibre—the size of the one very much depending upon that of the other. It begins by the confluence of some small veins in the submaxillary region, and descends vertically at a short distance from the mesial plane. Immediately above the inner end

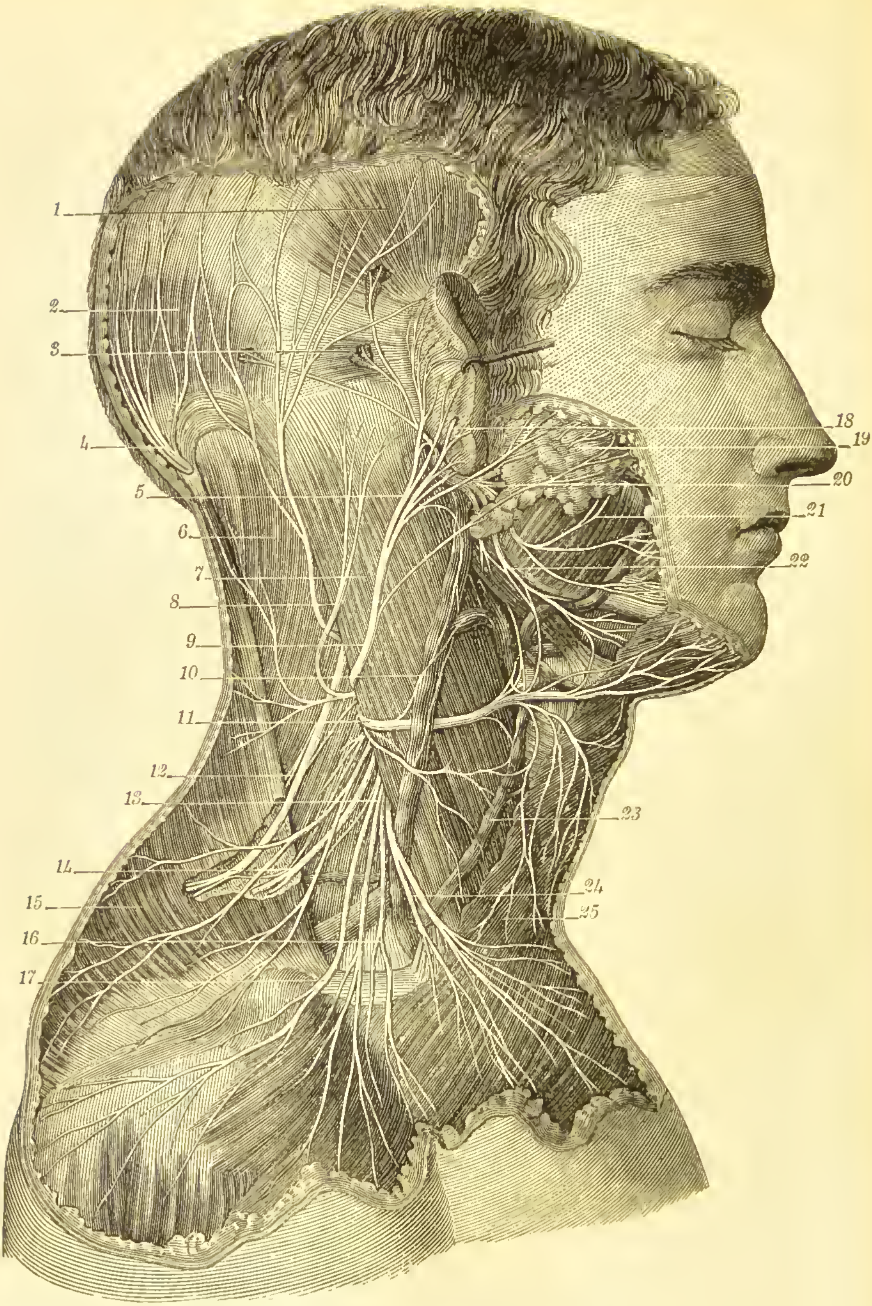

FIG. 208.—Superficial nerves on the side of the neck and back of the scalp.—(HIRSCHFELD and LEVEILLÉ).

1. Attollens auriculam
2. Posterior belly of occipito-frontalis
3. Retrahens auriculam
4. Great occipital nerve
5. Great auricular nerve
6. Splenius muscle
7. Sterno-mastoid muscle
8. Small occipital nerve (present as two branches)
9. Great auricular nerve
10. External jugular vein
11. Superficial cervical nerve
12. Spinal accessory nerve
13. Descending branches of cervical plexus
14. Cervical branches to trapezius
15. Trapezius muscle
16. Supra-clavicular branches
17. Supra-acromial branches
18. Auricular twigs of great auricular nerve
19. Parotid gland
20. Facial nerve
21. Masseter muscle
22. Infra-mandibular nerve
23. Anterior jugular vein
24. Supra-sternal branches
25. Platysma myoides

of the clavicle it will be observed to dip through the deep cervical fascia. It terminates by turning abruptly outwards under cover of both heads of the sterno-mastoid muscle, and opening into the external jugular or into the subclavian vein. After it has pierced the fascia, a short transverse branch which crosses the mesial plane connects it with its fellow of the opposite side.

Superficial Branches of the Cervical Plexus.—These all take origin from the second, third, and fourth cervical nerves, and emerging from under cover of the posterior margin of the sterno-mastoid about its middle, pierce the deep fascia, and arrange themselves into *ascending*, *transverse*, and *descending branches.*

The *ascending branches* are two in number, and both have already been examined in the superficial dissection of the back of the neck (p. 109). They are (*a*) the *small occipital* —Fig. 208 (8),—springing from the second cervical nerve, and (*b*) the *great auricular*—Fig. 208 (9),—which takes origin from the second and third cervical nerves.

The *transverse branches* proceed from a single nerve called the *superficial cervical nerve*—Fig. 208 (11). This arises from the second and third cervical nerves, and winding round the posterior border of the sterno-mastoid about its middle, proceeds transversely forwards upon the deep fascia to reach the area over the anterior triangle of the neck. Here it divides into two branches, of which one inclines upwards and the other downwards. The *upper branch* communicates freely with the infra-mandibular division of the facial nerve and forms one or more wide loops with it in the region between the hyoid bone and the mandible (Fig. 208). Its branches pierce the platysma and supply the skin as high as the base of the lower jaw. The *lower branch* can be traced as low as the sternum. Its branches also reach the skin by piercing the platysma.

The *descending branches* take origin by a single large trunk from the third and fourth cervical nerves. This

emerges from under the posterior border of the sterno-mastoid, and soon breaks up into several twigs, which pierce the deep fascia and spread out widely from each other as they descend over the lower part of the posterior triangle, under cover of the platysma. The ultimate distribution of these twigs is to the integument over the upper part of the front of the chest and over the shoulder. To gain this destination they are carried downwards over the clavicle and acromion process, and are classified into three groups according to their position—viz. (1) *supra-acromial;* (2) *supra-clavicular;* (3) *supra-sternal*—Fig. 208 (17, 16, 24).

Infra-Mandibular Division of Facial Nerve.—After emerging from the parotid gland this nerve pierces the deep fascia. It will be found immediately below the angle of the lower jaw. Its branches spread forwards and form a series of loops which extend as low down as the hyoid bone. It is the nerve of supply to the platysma muscle, and effects a free communication with the upper branch of the superficial cervical nerve (Fig. 208 (22)).

Deep Cervical Fascia (Fig. 209).—The cervical fascia should now be cleaned, and its connections studied. It constitutes a continuous and strong aponeurotic envelope for the neck, very much in the same manner that the brachial aponeurosis invests the upper arm or the fascia lata the thigh. As in the case of these fasciæ also, processes are given off from its deep surface which penetrate into the neck to form sheaths for the various structures enclosed within the general investment. Certain of these processes stretch across the mesial plane in the form of partitions or septa, which subdivide the neck into fascial compartments. Let us first examine the general envelope as it is at present displayed, and then we shall be in a position to study the more important septa and processes.

The envelope formed by the deep cervical fascia is not equally developed in all subjects. In many cases, and more especially in females, it is thin and inconspicuous.

Neither is it of equal strength at all points. As it stretches over the triangles of the neck, it is distinctly stronger than where it covers either the trapezius or sterno-mastoid. Traced backwards, it splits at the anterior border of the trapezius into two lamellæ to enclose this muscle. The superficial layer is very thin, and both blend posteriorly with the

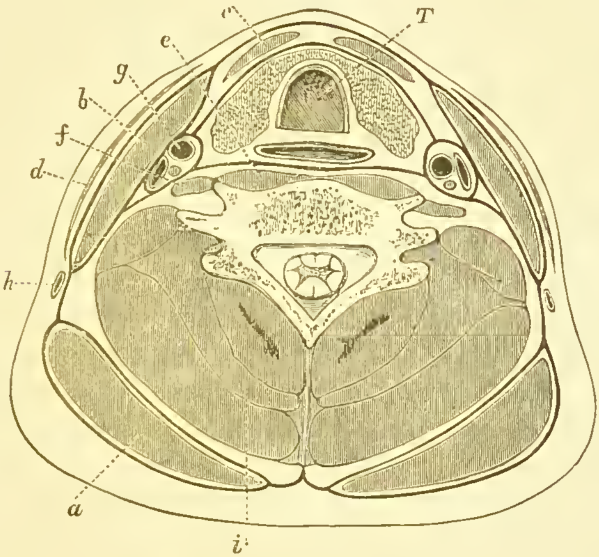

FIG. 209.—Diagrammatic representation of a transverse section through the neck at the level of the isthmus of the thyroid body to show the arrangement of the cervical fascia. (TREVES.)

T. Trachea.
c. Depressor muscles of the larynx and hyoid bone.
e. Prevertebral muscles.
g. Carotid artery and its sheath.
b. Sterno-mastoid.
f. Scalenus anticus.
d. Platysma.
h. External jugular vein.
a. Trapezius.
i. Deep muscles on back of neck.

ligamentum nuchæ. When the investing aponeurosis is followed forwards it is found to split again at the posterior border of the sterno-mastoid into two lamellæ, which encase that muscle and re-unite at its anterior margin. Of these layers the superficial is so delicate that the fleshy fasciculi

of the muscle are distinctly seen through it. From the sterno-mastoid the aponeurosis is prolonged over the anterior triangle to the middle line, and passes continuously over to the opposite side of the neck. In its passage, however, from one side to the other, it obtains a firm attachment to the hyoid bone.

Its connections at the upper and lower limits of the neck may now be examined. *Above*, it is attached along the whole length of the base of the lower jaw. Behind the angle of the jaw it is carried upwards upon the surface of the parotid gland, as the parotid fascia, to gain attachment to the lower margin of the zygoma—a connection which will be afterwards seen in the dissection of the face. Still farther backwards, it is fixed to the mastoid process, and to the superior curved line of the occipital bone.

Its connections *below* are no less definite. It is attached to the anterior border of the clavicle, and to the top of the sternum. The latter attachment, however, is of a somewhat intricate character. As it is traced downwards between the two sterno-mastoid muscles, it will be found to split a short distance above the sternum into two layers. Of these, the superficial layer is very weak, and is attached to the anterior border of the manubrium sterni. The deeper layer lies immediately in front of the sterno-hyoid and sterno-thyroid muscles, and is fixed below to the posterior border of the manubrium sterni and to the inter-clavicular ligament. Upon either side the two layers unite beyond the sternal head of origin of the sterno-mastoid; and the space between them contains—(1) a little fatty areolar tissue; (2) the two anterior jugular veins for a very short part of their course; (3) the cross branch of communication between the anterior jugular veins of opposite sides when this exists; (4) sometimes a lymphatic gland; and (5) the sternal heads of the sterno-mastoid muscles. Open into the space by dividing the anterior layer close to the sternum, and gauge its extent by means of the handle of the knife.

The *processes* and *partitions* which proceed from the deep surface of the cervical fascia cannot in every case be displayed at the present stage of the dissection, but it is necessary that they should be described, in order that the student may be able to recognise them and appreciate their bearings as they are unfolded in the subsequent dissection of the neck. Those requiring special notice are:—

1. The prevertebral fascia.
2. The pretracheal fascia.
3. The carotid sheath.
4. The stylo-maxillary ligament.

The *prevertebral fascia* is a strong partition which stretches across the neck immediately in front of the vertebral column and the prevertebral muscles. On either side it extends outwards behind the carotid vessels and the internal jugular vein, to obtain attachment to the layer of the investing aponeurosis which lies on the deep surface of the sterno-mastoid muscle. In an upward direction it can be traced to the base of the skull to which it is fixed, whilst below it passes continuously downwards into the thorax upon the longus colli muscles. The prevertebral fascial septum thus subdivides the investing tube of cervical fascia into—(*a*) a posterior compartment which contains the vertebral column and the muscles which surround it; and (*b*) an anterior or *visceral compartment*, which contains the pharynx, the larynx, the trachea, the gullet, the thyroid body, and the depressor muscles of the larynx and hyoid bone. It is important to note that there is no barrier interposed between this visceral compartment and the superior mediastinal space of the thoracic cavity.

The *pretracheal fascia* is a partition of no great strength, which springs from the deep aspect of the lamella clothing the deep surface of the sterno-mastoid. It passes right across the visceral compartment of the neck in front of the thyroid body and trachea, and behind the anterior belly of the omo-hyoid, the sterno-thyroid, and sterno-hyoid muscles.

It gives off processes which ensheath the thyroid body and the trachea, and is prolonged downwards into the thorax in front of the great vessels at the root of the neck, to gain an attachment to the fibrous layer of the pericardium.

The great vessels of the neck lie under cover of the sterno-mastoid muscle, and are contained within the outermost part of the visceral compartment on either side of the neck. They are enclosed within a special investment of fascia which receives the name of the *carotid sheath.* Both the prevertebral and the pretracheal septa take part in the formation of this sheath, and in addition to the carotid artery and the internal jugular vein there are included within it the vagus and the descendens hypoglossi nerves. Further, the gangliated cord of the sympathetic may be considered to be embedded in its posterior wall.

The *stylo-maxillary ligament* is a strong process of the cervical fascia in the upper part of the neck, which passes from the angle and posterior margin of the lower jaw to the styloid process. It is firmly attached to these bones, and is so placed that it constitutes a firm fibrous partition between the submaxillary and parotid glands. It can readily be exposed at the present stage.

Dissection.—The sterno-mastoid muscle, as we have observed, divides the side of the neck into two triangular spaces—an anterior triangle placed in front of it, and a posterior triangle behind it. This muscle, therefore, should be studied before proceeding further. Carcfully clean its superficial surfacc, and define its attachments. It may also be raised in its lower two thirds from the subjacent layer of deep cervical fascia. In doing this care must be taken not to injure the sterno-mastoid branch of the superior thyroid artery which will be seen entering its deep surface. In its uppcr third it should be left undisturbed in the meantime.

Sterno-Mastoid (sternocleidomastoideus).—The sterno-mastoid muscle takes its origin below by two heads—a sternal and a clavicular. The *sternal head* is rounded, and chiefly tendinous, and springs from the upper part of the anterior face of the manubrium sterni. The *clavicular head* is broad

and fleshy, with only a few tendinous fibres intermixed, and it arises from the inner third of the upper surface of the shaft of the clavicle. A narrow interval separates these heads below, but at a higher level the sternal portion overlaps the clavicular, whilst half-way up the neck they both unite into a fleshy mass which ascends to the mastoid process and occiput. Here the muscle expands somewhat. In front, it is thick and tendinous, and is inserted into the fore part and outer surface of the mastoid process; behind, it is thin and aponeurotic, and is inserted into rather more than the outer half of the superior curved line of the occipital bone. In the dissection of the back, this latter part of the muscle has been detached from the occiput.

Dissection.—The posterior triangle of the neck should be dissected first. For this purpose the shoulder must be depressed and the head pulled well over to the opposite side and supported upon a block. This interferes, of course, with the dissection of the axilla. It is necessary, therefore, that the dissectors of the head and neck, and of the upper limb, should arrange to work at different hours. Again, the lower part of the posterior triangle, and the upper part of the axilla, constitute a region of the highest importance to both dissectors, seeing that it is here the great blood-vessels and nerves leave the root of the neck and enter the arm. Arrangements, therefore, must be made for each to have an opportunity of studying these structures. But in this a difficulty arises. Four days are required to complete the dissection of the axilla, whilst two days are amply sufficient for the dissection of the superficial parts of the neck and the posterior triangle. It is not necessary, however, that the dissector of the head and neck should stop work. After he has displayed the parts in the space as far as he can without dividing the clavicle, he may proceed with the dissection of the anterior triangle, and on the fourth day return to the posterior triangle and complete the work with the co-operation of the dissector of the arm.

The upper part of the posterior triangle has already been displayed in the dissection of the posterior aspect of the neck (p. 141), but it can only be studied in its entirety when the subject is placed upon its back. The trapezius which has been reflected should be restored as far as possible to its natural position and retained by means of a stitch.

When the investing cervical fascia which bridges over the lower part of the posterior triangle between the trapezius and the sterno-mastoid muscles is removed, a variable amount of fatty areolar tissue is exposed

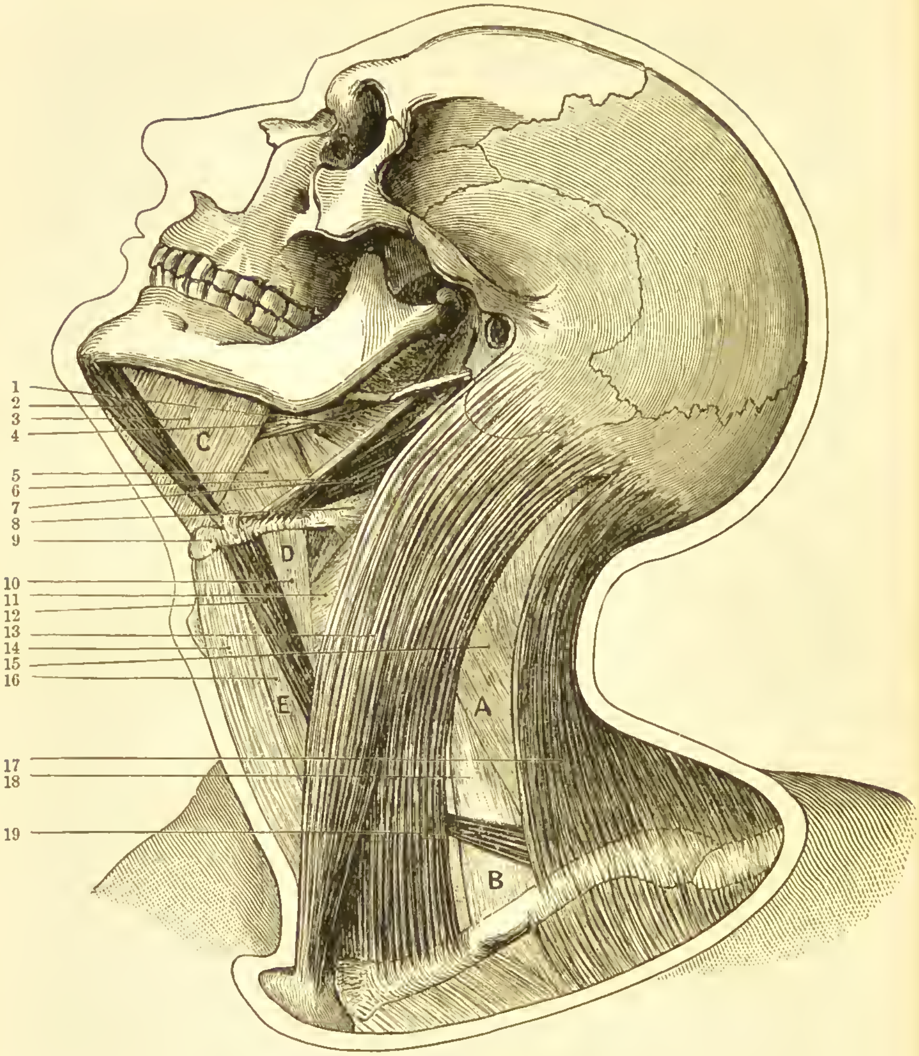

FIG. 210.—Triangles of the neck.

A. Occipital triangle.
B. Subclavian triangle.
C. Digastric triangle.
D. Carotid triangle.
E. Muscular triangle.
1. Superior constrictor.
2. Anterior belly of digastric.
3. Mylo-hyoid.
4. Stylo-glossus.
5. Hyo-glossus.
6. Stylo-hyoid.
7. Posterior belly of digastric.
8. Middle constrictor.
9. Hyoid-bone.
10. Thyro-hyoid.
11. Inferior constrictor.
12. Omo-hyoid.
13. Sterno-mastoid.
14. Sterno-hyoid.
15. Levator anguli scapulæ.
16. Sterno-thyroid.
17. Trapezius.
18. Scalene muscles.
19. Omo-hyoid.

in the supra-clavicular region. Embedded within this will be found the transversalis colli and the supra-scapular vessels, with the posterior belly of the omo-hyoid muscle and some lymphatic glands. The supra-scapular artery emerges from under cover of the sterno-mastoid, and passes outwards immediately subjacent to the clavicle ; the transversalis colli artery also comes out from under cover of the sterno-mastoid, but it lies at a higher level. The posterior belly of the omo-hyoid muscle is a narrow muscular band which appears at the angle which is formed by the anterior border of the trapezius muscle and the clavicle, and proceeds forwards and upwards on the side of the neck to disappear under cover of the sterno-mastoid. It should be noted that the posterior belly of the omo-hyoid muscle is enveloped in a sheath of fascia which is loosely disposed around it, and is then prolonged downwards to obtain an attachment to the clavicle. As the muscle disappears under cover of the sterno-mastoid it gives place to a rounded tendon. Upon the under surface of this, closely applied to it, and between the two layers of fascia which invest it will be found a minute nervous twig which comes from the ansa hypoglossi, and ends in this portion of the omo-hyoid. The lymphatic glands in this region belong to the group which receive the name of *inferior deep cervical glands.* When the fatty areolar tissue is removed from these structures, a strong layer of fascia spread over the subclavian vessels and the brachial nerves will be brought into view.

Deep Layer of Fascia in the Supra-clavicular Region.— This a strong sheet of fascia which is spread over the brachial nerves and the subclavian vessels. When traced inwards under cover of the sterno-mastoid it will be observed to cover the scalenus anticus muscle and to become continuous with the prevertebral fascia and the posterior part of the carotid sheath. In a downward direction it may be followed into the axilla as the sheath of the axillary vessels and nerves, and here it establishes a connection with the costo-coracoid membrane. A distinct space or interval exists between this deep layer of fascia and the investing fascia of the neck. This interval is filled with fatty areolar tissue, and also contains the transversalis colli and supra-scapular vessels, the posterior belly of the omo-hyoid muscle, and some of the inferior deep cervical glands. Seeing that the investing cervical fascia is attached to the clavicle, and

the deep layer of fascia is more or less intimately connected with the costo-coracoid membrane, the intra-aponeurotic space between them extends downwards for a short distance behind the clavicle. An incision should now be made through the deep layer of fascia as it lies over the great brachial nerves. If the handle of the knife be introduced into this and passed downwards along the course of the nerves behind the fascia, it will be found to proceed with the greatest freedom into the axilla.

Dissection.—The dissector should now proceed with the dissection of the posterior triangle. The deep layer of fascia which is spread over the great vessels and nerves must be removed. The brachial nerves will then be seen emerging from between the scalenus anticus and the scalenus medius muscles. At this stage in the dissection the minute nerve of supply to the subclavius is apt to be injured. It passes vertically downwards upon the superficial aspect of the brachial nerves, and must be secured before they are touched. The brachial nerves are closely matted together by dense connective tissue, which must be removed, but care must be taken at the same time not to injure the branches which spring from them. When the lowest trunk of the brachial plexus is reached the subclavian artery will come into view. This vessel must be thoroughly displayed, and the groove on the first rib on which it lies may be rendered evident by scraping it with the handle of the knife. By tracing the external jugular vein downwards, the subclavian vein will be found lying very deeply behind the clavicle. The scalenus anticus muscle, with the phrenic nerve passing downwards upon its anterior surface, will also be observed. Both lie under cover of the sterno-mastoid muscle.

Posterior Triangle.—This is a long, narrow, triangular space placed between the posterior border of the sterno-mastoid and the anterior border of the trapezius. It is covered by the superficial and deep fasciæ of the neck, and also in its lower part by the platysma myoides muscle. Certain cutaneous nerves and the external jugular vein have also been noticed in the superficial fascia which is spread over this area. Near the occiput is the small occipital nerve; near the clavicle are the supra-clavicular descending branches of the cervical plexus, and a very short portion of the external jugular vein.

In front, the posterior triangle is bounded by the posterior margin of the sterno-mastoid, and *behind*, by the anterior margin of the trapezius. The *base* which is below is formed by the middle third of the clavicle, whilst the *apex* which is above is formed by the meeting of the sterno-mastoid and trapezius on the superior curved line of the occipital bone.

The posterior belly of the omo-hyoid, which crosses the lower part of the posterior triangular space, subdivides it into an upper portion called the occipital triangle, and a lower part termed the supra-clavicular or subclavian triangle.

The Occipital Triangle is much the larger subdivision. It is bounded in front by the sterno-mastoid; behind by the trapezius; whilst its base is formed by the omo-hyoid.

Within the limits of the occipital triangle, we find the following structures:—

1. The *occipital artery* in a very small part of its course, and only when the sterno-mastoid fails to meet the trapezius at the apex of the triangle.
2. The spinal accessory nerve.
3. The branches from the third and fourth cervical nerves which cross the space to supply the trapezius muscle.
4. The superficial branches of the cervical plexus as they appear at the posterior border of the sterno-mastoid previous to piercing the deep fascia.
5. Branches of supply to the levator anguli scapulæ from the third and fourth cervical nerves.
6. The transversalis colli artery and vein, which cross the lower part of the space.
7. The upper part of the brachial plexus of nerves.

The contents of the occipital triangle have already in a great measure been studied (p. 141).

The Supra-Clavicular Triangle is a very small space. It is bounded above by the omo-hyoid; below by the clavicle; and in front by the sterno-mastoid. The area thus circumscribed is very variable in its extent in different subjects. Indeed, in the natural position of parts, the posterior belly of the omo-hyoid passes forwards so close to the clavicle that a very small interval is left between them, and it is

only after the fascial connections of the muscle have been divided that the triangle becomes well marked.

Cases also occur in which the omo-hyoid takes partial or complete origin from the clavicle, and thus the supra-clavicular space is still further reduced in size. Another condition which materially affects the dimensions of the supra-clavicular triangle is the muscular development of the subject. The more powerful the neck, the more extensive are the attachments of the trapezius and sterno-mastoid to the clavicle, and the narrower in consequence is the triangle. In a few instances these muscles will be observed to meet on the clavicle, and thus obliterate the space altogether. This latter condition, however, is not necessarily associated with a specially high development of the muscles.

In the supra-clavicular space a great number of highly important structures are collected together within a very limited area. The great blood vessels and nerves which pass from the neck to the upper limb traverse this space. Its contents are the following :—

Arteries—
- Subclavian.
- Transversalis colli.
- Supra-scapular.

Veins—
- External jugular.
- Supra-scapular.
- Transversalis colli.
- Subclavian.

Nerves—The trunks of the brachial plexus and their branches.

Lymphatic glands.

Subclavian Artery (arteria subclavia).—It is only the *third part* of the subclavian artery which is included in the supra-clavicular triangle. This portion of the vessel extends from the outer margin of the scalenus anticus to the outer border of the first rib. Here it enters the axilla and becomes the axillary artery. It takes a very oblique course; at first it lies at a variable distance above the level of the clavicle, but as it runs from above downwards and outwards, it finally comes to lie behind the clavicle and the subclavius muscle.

It is this portion of the artery that the surgeon selects, when the choice lies in his own hands, as the seat for apply-

ing a ligature. Its relations, therefore, must be studied with especial care.

In front of the vessel are the coverings of the space in which it lies—viz., superficial fascia, platysma, superficial descending supra-clavicular branches of the cervical plexus, and the deep cervical fascia. Towards its termination, however, as we have seen, it passes behind the clavicle and subclavius muscle, and here also it is crossed by the supra-scapular artery. But perhaps the most important anterior relation, and one which, in tying the vessel, may somewhat embarrass the surgeon, is that established by the external jugular vein and certain of its tributaries. This vein crosses in front of the artery close to the scalenus anticus, and whilst occupying this position, two, or it may be three, tributaries join it—viz., the transversalis colli, the supra-scapular, and the anterior jugular veins. Observe further that the small nerve to the subclavius is carried vertically downwards in front of the artery.

Below, the third part of the subclavian artery rests upon the first rib; at *a higher level*, and also emerging from under cover of the scalenus anticus, are the brachial nerves. *Behind*, the vessel is in contact with the scalenus medius, although the lowest brachial nerve trunk may intervene between the muscle and the artery. The *subclavian vein* is placed at a lower level than the artery, and on a plane slightly anterior to it.

Although, as a rule, no branch springs from this portion of the subclavian, it is not uncommon to find the *posterior scapular artery* taking direct origin from its upper surface.

Surgical Anatomy.—The dissector should again examine the relations of the subclavian artery, with the view of determining those which would constitute the most trustworthy guides in cases where it is necessary to apply a ligature to its third part. He should note that the posterior belly of the omo-hyoid will give no information beyond that of the *depth* at which the operator has arrived. The true guide is the *outer border of the scalenus anticus muscle.* This, as a rule, lies immediately subjacent to the posterior margin of the sterno-mastoid. By

passing the forefinger downwards along the outer margin of the scalenus anticus, the *scalene tubercle* on the first rib will be reached. When the finger-nail rests on this tubercle the finger-pulp is applied to the artery, and in the living subject will feel its pulsations.

Supra-scapular and Transversalis Colli Arteries.—Both of these arteries will be observed emerging from under cover of the outer border of the sterno-mastoid. Their origin from the thyroid axis will be seen in a subsequent dissection.

The supra-scapular artery (arteria transversa scapulæ) proceeds outwards under shelter of the clavicle and across the third part of the subclavian artery and the brachial nerves. At the outer limit of the supra-clavicular triangle it passes under cover of the trapezius to reach the superior border of the scapula where it has already been examined (p. 143). The *transversalis colli* (arteria transversa colli) is placed at a higher level, and is carried outwards across the posterior triangle. It passes under cover of the posterior belly of the omo-hyoid and, as a rule, superficial to the brachial nerves. It has already been observed to end under cover of the anterior margin of the trapezius, by dividing into the posterior scapular and the superficial cervical arteries (p. 142).

Veins.—The arrangement of the veins has been noticed in studying the relations of the subclavian artery. The *external jugular vein*, as a rule, crosses the third part of this artery and joins the subclavian vein. It is joined close to its termination by the supra-scapular and transversalis colli veins, and perhaps by the anterior jugular as it emerges from under cover of the sterno-mastoid. In many cases, however, the anterior jugular joins the subclavian vein directly.

Floor of the Posterior Triangle.—The floor of the posterior triangular space is formed by a succession of muscles, and at its very lowest part by a small portion of the first rib. In the *occipital subdivision* the dissector will observe that the floor is constituted from above downwards

by—(1) the splenius capitis; (2) the levator anguli scapulæ; and (3) by the scalenus medius and posticus. At the apex of the triangle an additional factor may sometimes be observed—viz., a small portion of the complexus.

In the *supra-clavicular triangle* the floor lies very deeply. It is formed by the scalenus medius and posticus, a portion of the first rib, and a small part of the first digitation of the serratus magnus muscle.

Section of the Clavicle.—In order that a satisfactory view may be obtained of the nerves forming the brachial plexus, it is necessary to remove the middle third of the clavicle. This, of course, can only be done when the dissector of the upper limb has completed the dissection of the axilla. Saw through the clavicle at two points—viz., at the posterior margin of the sterno-mastoid, and the anterior margin of the trapezius—and remove the intermediate piece of bone, after having carefully detached it from the subclavius. The nerve to the subclavius should now be traced to its distribution. Then divide the fibres of the subclavius which still adhere to the acromial third of the clavicle, and throw the muscle inwards. This will allow the shoulder to drop well backwards.

Brachial Plexus.—This great nervous plexus is formed by the anterior primary divisions of the four lower cervical nerves and the greater part of the large anterior primary division of the first dorsal nerve. Above, the plexus is further reinforced by a very small twig of communication which passes from the fourth to the fifth cervical nerve, whilst below, a similar connecting twig not infrequently passes upwards in front of the neck of the second rib from the second to the first dorsal nerve. The five brachial nerves are brought into connection with the middle and inferior ganglia of the cervical sympathetic by means of fine rami communicantes.

The great brachial nerves emerge from the interval between the scalenus anticus and scalenus medius, and proceed downwards and outwards through the lower part of the posterior triangle towards the axilla. The manner in which they unite to form the plexus is upon the whole very

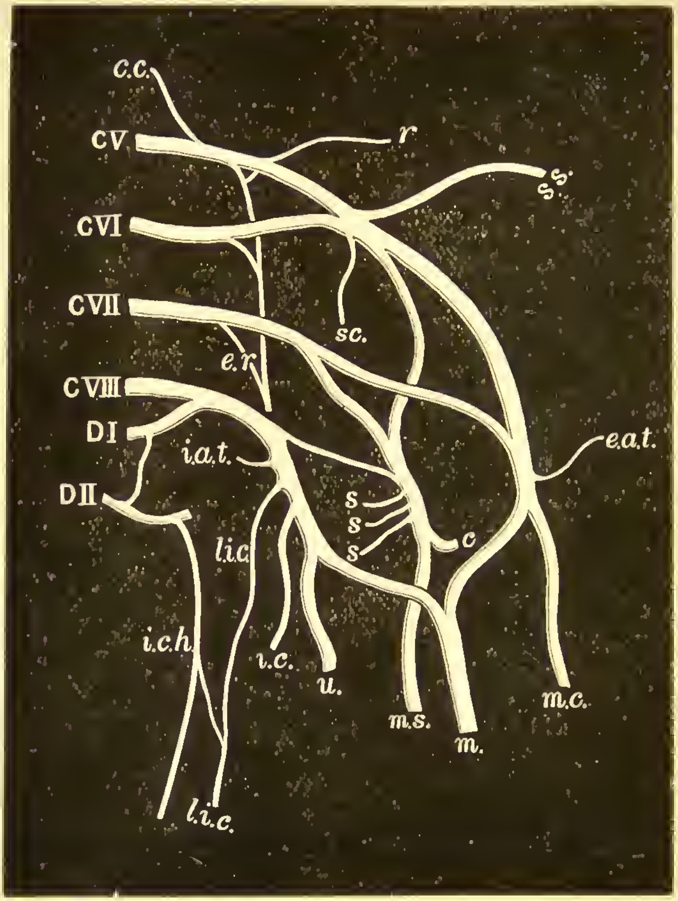

FIG. 211.—Diagram of the brachial plexus.

CV, CVI, CVII, CVIII. The four anterior primary divisions of the cervical spinal nerves which take part in its formation.

DI and *DII*. The anterior primary divisions of the first two dorsal nerves.
c.c. Communicating twig from the fourth cervical nerve.
r. Nerve to rhomboids.
ss. Supra-scapular nerve.
sc. Nerve to subclavius.
e.r. External respiratory nerve, or nerve of Bell.
e.a.t. External anterior thoracic nerve.
m.c. Musculo-cutaneous nerve.
m. Median nerve.
i.a.t. Internal anterior thoracic nerve.
l.i.c. Lesser internal cutaneous nerve, or the nerve of Wrisberg.
i.c.h. Intercosto-humeral nerve.
i.c. Internal cutaneous nerve.
u. Ulnar nerve.
s.s.s. The three subscapular nerves.
c. Circumflex nerve.
m.s. Musculo-spiral nerve.

constant. The *fifth* and *sixth* nerves unite to form an *upper trunk;* the *seventh* nerve remains single and proceeds downwards as a *middle trunk;* and the *eighth cervical* and *first dorsal* nerves join, whilst still under cover of the scalenus anticus, to constitute a third or *lower trunk.* Whilst still within the posterior triangle of the neck each trunk splits into an *anterior* and a *posterior division.* Raise the three anterior divisions on the handle of the knife, and then it will be seen that the three posterior divisions unite to form the *posterior cord* of the plexus, and, further, that the innermost of these divisions is much smaller than the other two. Of the three anterior divisions the *outer two* join to constitute the *outer cord*, whilst the *innermost* is carried down by itself as the *inner cord* of the plexus. From the three cords of the brachial plexus are given off the branches which supply the upper limb.

From the above description it will be seen that the plexus, from changes which are effected in the arrangement of its fibres, may be divided into four stages:—

1st Stage.	2nd Stage.	3rd Stage.	4th Stage.
5 separate nerves (viz., 4 lower cervical and first dorsal).	3 nervous trunks (viz., an upper, middle, and lower).	3 anterior divisions and 3 posterior divisions.	3 nervous cords (viz., an outer, inner, and a posterior).

The first three of these stages are generally observed in the lower part of the posterior triangle and in the upper part of the axilla. It must be understood, however, that the points at which division and union of the different parts of the plexus takes place are subject to some variation.

Supra-clavicular Branches of the Brachial Plexus.—The only branches of the brachial plexus which fall to the lot of the dissector of the head and neck, are those given off above

the level of the clavicle. These are for the most part destined for the supply of muscles in the neighbourhood. They are :—

1. Nerve to rhomboids,	from the 5th cervical nerve.
2. Nerve to subclavius 3. Supra-scapular,	from the 5th and 6th cervical nerves.
4. External respiratory nerve of Bell,	from the 5th, 6th, and 7th cervical nerves.
5. Twigs to scalene muscles and longus colli,	from various cervical nerves before they enter the plexus.
6. Communicating twig to phrenic nerve,	from 5th cervical.

The *nerve to the rhomboids* is a long slender branch which springs, by a stem common to it and the uppermost root of the nerve of Bell, from the fifth cervical nerve as it lies upon scalenus medius. Draw the fifth cervical nerve forwards, and the branch in question will be seen passing backwards through the fibres of that muscle to reach the deep surface of the levator anguli scapulæ. It here meets the posterior scapular artery, and proceeds with it downwards under cover of the rhomboid muscles close to the base of the scapula. It supplies one or two twigs to the levator anguli scapulæ, and is finally exhausted in the rhomboids.

The *nerve to the subclavius* is a minute twig which springs from the upper trunk of the plexus, and then passes vertically downwards upon the plexus, and across the subclavian artery to the subclavius muscle, which it reaches by piercing the posterior lamina of its sheath.

A communication between the nerve to the subclavius and the phrenic is by no means uncommon. This connecting filament may join the phrenic in the neck or in the thorax. In all probability, it represents that communicating twig (or at least a portion of it) which, on other occasions, passes directly from the fifth cervical nerve to the phrenic.

The *supra-scapular nerve* is the largest branch given off above the clavicle. It springs from the upper trunk of the plexus, and runs downwards, outwards, and backwards, at a

higher level than the brachial nerves, to the supra-scapular notch of the scapula, through which it enters the supra-spinous fossa. As it approaches the scapula, it passes under cover of the trapezius and posterior belly of the omo-hyoid, and comes into relation with the artery of the same name.

The *external respiratory nerve of Bell*, also called the *posterior thoracic*, is formed by the union of three roots. The roots from the fifth and sixth cervical nerves pass backwards through the fibres of the scalenus medius, and unite into one stem which gives branches to the upper part of the serratus magnus. The third root from the seventh cervical nerve does not pierce the scalenus medius. It is carried downwards on the surface of that muscle, and ultimately joins the stem formed by the union of the upper two roots. The posterior thoracic nerve enters the axilla behind the axillary vessels, and is entirely devoted to the supply of the serratus magnus muscle.

Dissection.—At this stage, the dissector of the upper limb removes the arm from the trunk. The dissector of the head and neck must see that the vessels and nerves are not cut too short. The outer border of the first rib is the level at which they should be divided.

The dissector should now proceed with the dissection of the anterior triangle. In this dissection the visceral compartment of the neck is opened up, and its contents displayed. Let the head hang well over the end of the table, and, raising the lower jaw as much as possible, fix it in this position by means of hooks. Begin the dissection by throwing the superficial cervical and infra-mandibular nerves backwards, and then carefully raise the cervical fascia from the area in front of the sterno-mastoid. The anterior triangle is subdivided into three smaller triangles by three muscles which traverse it in different directions. These muscles are:—(1) the anterior belly of the omo-hyoid; (2) the digastric; and (3) the stylo-hyoid. It is well, therefore, at this stage to define these muscles, and accurately determine the precise position and extent of each subdivision of the space. The *anterior belly of the omo-hyoid* appears by emerging from under cover of the anterior border of the sterno-mastoid, a short distance above its sternal origin. It crosses the space very obliquely, running upwards and forwards to the body of the hyoid bone. The *digastric*, as its name implies, is a two-bellied muscle. The posterior belly comes out from under cover of the

sterno-mastoid, close to the mastoid process, and behind the lower part of the parotid gland. It proceeds downwards and forwards to the hyoid bone, and there the intermediate tendon is developed. The anterior belly is directed upwards and forwards to the symphysis of the lower jaw. The intermediate tendon of the digastric muscle is bound down to the hyoid bone by a process of deep fascia, and in cleaning the muscle, care must be taken not to detach this. The *stylo-hyoid* muscle lies on a deeper plane than the posterior belly of the digastric, and in relation to the upper border. It is pierced by the digastric tendon at the hyoid bone. In the first instance, merely clean the superficial surface of these muscles. In the case of the anterior belly of the omo-hyoid, be careful not to injure the twigs from the descendens hypoglossi nerve, which enter its upper border, and, whilst dealing with the digastric muscle, bear in mind that the facial vein, and the anterior division of the temporo-maxillary vein, usually descend superficial to its posterior belly, and must be secured before the muscle is touched. The filaments from the mylo-hyoid nerve, which enter the upper border of its anterior belly, are not liable to injury if ordinary caution be exercised.

Anterior Triangle of the Neck.—The anterior triangle differs from the posterior triangle in having its base above and its apex below. It is bounded *behind* by the anterior margin of the sterno-mastoid, and *in front* by the middle line of the neck. Its *base* is formed by the inferior margin of the lower jaw, and a line drawn from the angle of the mandible to the sterno-mastoid muscle, whilst its dependent *apex* is constituted by the meeting of its anterior and posterior limits at the upper border of the sternum.

Spread over the anterior triangle there are the skin, the superficial fascia with the platysma, and the deep cervical fascia. In the interval between the platysma and the deep fascia are placed the branches of the superficial cervical nerve, the infra-mandibular nerve, and also the anterior jugular vein.

Subdivisions of the Anterior Triangle. — Distinctive terms are applied to the three subsidiary triangles which are mapped out within the area of the anterior triangular space by the anterior belly of the omo-hyoid muscle and the two bellies of the digastric muscle. The lowest sub-

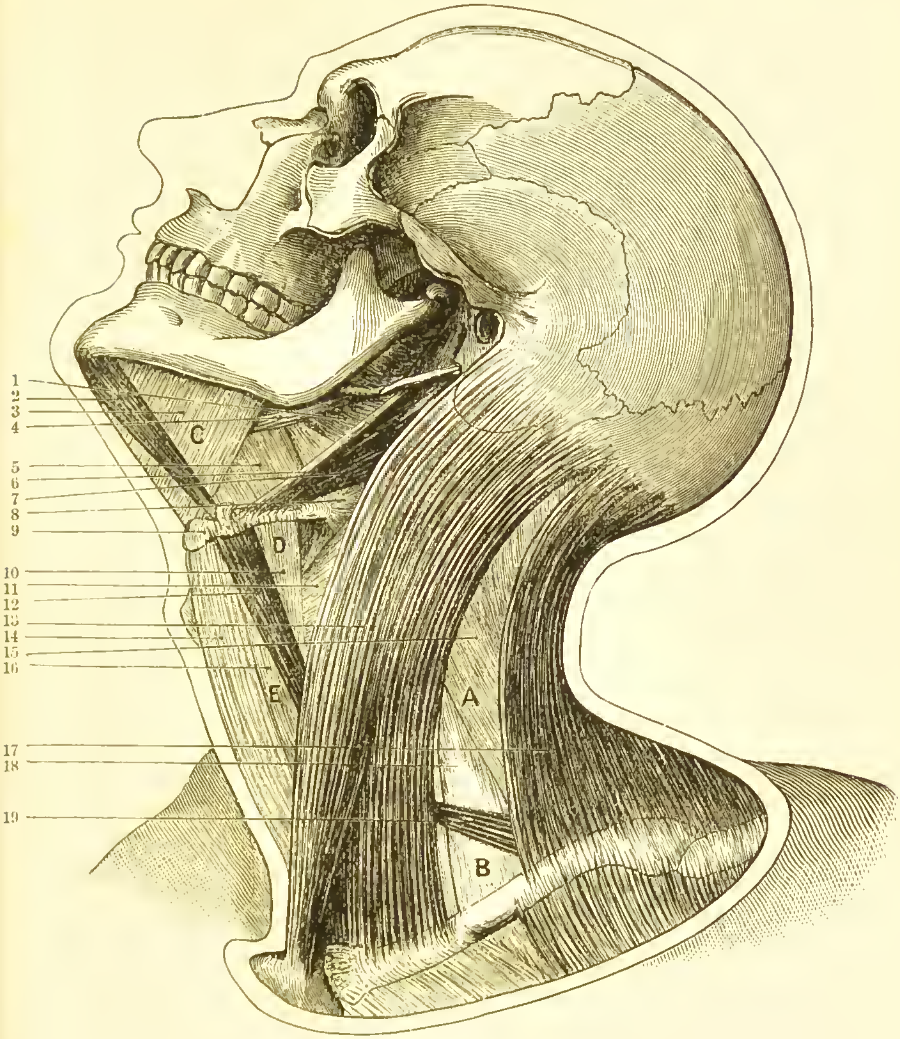

FIG. 212.—Triangles of the neck.

A. Occipital triangle.
B. Subclavian triangle.
C. Digastric triangle.
D. Carotid triangle.
E. Muscular triangle.
1. Superior constrictor.
2. Anterior belly of digastric.
3. Mylo-hyoid.
4. Stylo-glossus.
5. Hyo-glossus.
6. Stylo-hyoid.
7. Posterior belly of digastric.
8. Middle constrictor.
9. Hyoid-bone.
10. Thyro-hyoid.
11. Inferior constrictor.
12. Omo-hyoid.
13. Sterno-mastoid.
14. Sterno-hyoid.
15. Levator anguli scapulæ.
16. Sterno-thyroid.
17. Trapezius.
18. Scalene muscles.
19. Omo-hyoid.

division is termed the *lower* or *muscular triangle;* the intermediate space receives the name of *carotid triangle;* whilst the highest subdivision is called the *submaxillary* or *digastric triangle* (Fig. 212).

The *muscular triangle* is bounded *in front* by the middle line of the neck, and *behind* by the sterno-mastoid. Its *base* is above, and is formed by the anterior belly of the omo-hyoid, whilst its *apex* is below at the upper margin of the sternum.

The *carotid triangle* is limited *above* by the posterior belly of the digastric, and *below*, by the anterior belly of the omo-hyoid. Its *base* is directed backwards, and is formed by the sterno-mastoid, whilst its *apex* is at the hyoid bone.

The *digastric triangle* is bounded *below* and *behind* by the posterior belly of the digastric and the stylo-hyoid muscle, and *below* and in *front* by the anterior belly of the digastric. Its *base* is above, and is constituted by the body of the lower jaw, and a line drawn backwards from the angle of the mandible to the sterno-mastoid muscle; its *apex* points downwards, and is formed by the intermediate tendon of the digastric muscle.

Dissection.—The numerous and diverse structures contained within the anterior triangle must now be displayed. This is a dissection which requires care and some preliminary knowledge of the parts to be exposed. The student is therefore advised to read the general account which is given of the parts which are brought into view, as each subdivision of the space is opened up (p. 215 to p. 221), before undertaking the work. The dissection should be carried out over the entire area at once, and the structures found in one subdivision followed upwards or downwards, as the case may be, into the other subdivisions of the space. It is a common fault with dissectors to fail to open up the digastric triangle until the two lower triangles have been fully dissected. Two small nerves are especially liable to injury, and therefore should be secured as early as possible. They are the thyro-hyoid branch of the hypoglossal nerve and the external laryngeal nerve. The hypoglossal nerve, which will be found crossing the carotid triangle at the lower border of the posterior belly of the digastric, should be traced forwards;

as it approaches the hyoid bone, its minute thyro-hyoid branch will be discovered, leaving its lower border at an acute angle, and proceeding downwards and forwards to reach the thyro-hyoid muscle. The external laryngeal nerve is a long slender branch which occupies a deeper plane. To expose it the carotid vessels should be pulled outwards from the larynx. and the loose tissue in the interval thus opened up divided carefully in an oblique direction and along a line connecting the cricoid cartilage with the bifurcation of the common carotid artery. The nerve will be found as it passes downwards and forwards to disappear under cover of the depressor muscles of the larynx. It will be traced to its ultimate distribution at a subsequent stage of the dissection.

Muscular Triangle.—As this triangle is gradually opened up the following structures will come into view :—

1. The sterno-hyoid and sterno-thyroid muscles.
2. The branches from the ansa hypoglossi to these muscles.
3. The external laryngeal nerve.
4. The superior thyroid artery.
5. The greater part of the larynx, the thyroid body, and the trachea.
6. The œsophagus on the left side.
7. The recurrent laryngeal nerve.

When the fascia is removed from this part of the anterior triangle, the only structures which are seen within its limits are the sterno-hyoid and sterno-thyroid muscles. It is for this reason that the term *muscular* is applied to the space. As the dissection is proceeded with, however, the large nerve of supply for these muscles, which comes from the ansa hypoglossi, will be found lying near the outer border of the sterno-thyroid and breaking up into numerous twigs. Towards the upper part of the space the superior thyroid artery will be noticed passing downwards under cover of the omo-hyoid, sterno-thyroid, and sterno-hyoid muscles to reach the thyroid body. At a slightly higher level than this artery, the external laryngeal nerve runs forwards to end in the crico-thyroid muscle. Under cover of the sterno-hyoid and sterno-thyroid muscles will be observed the larynx, the isthmus and a considerable part of the lateral lobe of the thyroid body, and the trachea. The recurrent laryngeal nerve lies deeply. It will be found in the interval between the gullet

and trachea. As the œsophagus inclines to the left behind the trachea, it follows that it is only seen, when in its natural position, in the left muscular triangle.

Carotid Triangle.—During the dissection of the carotid triangle the following parts are displayed :—

Arteries:

1. Common carotid dividing into external and internal carotid arteries.
2. Superior thyroid.
3. Lingual.
4. Facial.
5. Occipital.
6. Ascending pharyngeal.
   (2–6: Branches of the external carotid.)
7. Hyoid.
8. Sterno-mastoid.
9. Superior laryngeal.
   (7–9: Branches of the superior thyroid.)
10. Sterno-mastoid branch of the occipital.

Veins:

1. Internal jugular.
2. Facial.
3. Anterior temporo-maxillary.
4. Lingual.
5. Superior thyroid.
   (2–5: Tributaries of the internal jugular.)

Nerves:

1. Hypoglossal. (Crossing the space in a transverse direction.)
2. Descendens hypoglossi.
3. Nerve to thyro-hyoid.
4. Internal laryngeal.
5. External laryngeal.
6. Spinal accessory.
   (2–6: Crossing the space obliquely.)
7. Vagus.
8. Sympathetic.
   (7–8: Descending vertically.)

Intercarotic body.
Portion of the larynx and pharynx.
Greater cornu of the hyoid bone.
Lymphatic vessels and glands.

This subdivision of the anterior triangle, when opened up, contains portions of each of the three carotid arteries. It therefore receives the name of *carotid triangle*. It is well, however, that the dissector should clearly understand that it is only after the parts are relaxed by dissection that these vessels come to lie within the space. When the fascia and

platysma are in position they are completely overlapped by the sterno-mastoid muscle. The common carotid artery is enveloped, along with the internal jugular vein and vagus nerve in a common sheath of fascia. The carotid sheath should be slit open, care being taken of the descendens hypoglossi nerve, which

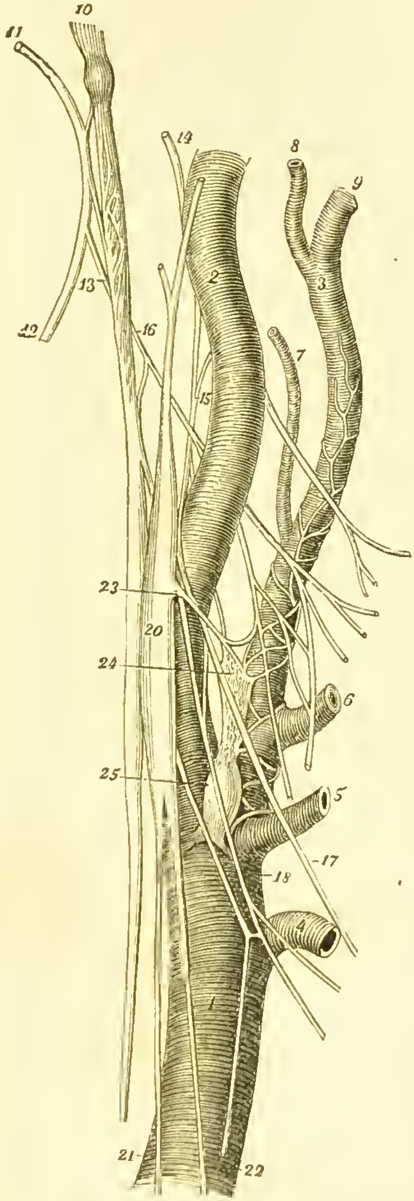

FIG. 213.—Deep aspect of carotid vessels, with the intercarotic body and the nerves in relation to them. (LUSCHKA.)

1. Common carotid.
2. Internal carotid.
3. External carotid.
4. Superior thyroid.
5. Lingual.
6. Facial.
7. Occipital.
8. Superficial temporal.
9. Internal maxillary.
10. Vagus nerve.
11. Spinal accessory.
12. External portion of spinal accessory.
13. Internal part of spinal accessory joining the vagus.
14. Glosso-pharyngeal.
15. Branches to carotid plexus.
16. Pharyngeal branch of vagus.
17. Superior laryngeal branch of vagus.
18. External laryngeal nerve.
20. Superior cervical ganglion.
21. Sympathetic cord.
22. Superior cardiac branch of sympathetic.
23. Sympathetic twigs to carotid plexus.
24. Carotid plexus.
25. Intercarotic body.

also descends obliquely within it. The intimate connection

which this sheath presents with the prevertebral layer of fascia can now be made out. The common carotid usually bifurcates opposite the upper border of the thyroid cartilage. Observe that the internal carotid artery at first lies *behind, and to the outer side* of the external carotid. Upon the coats of these vessels numerous sympathetic twigs ramify (Fig. 213), and, at the point of bifurcation of the common carotid, a small oval body, termed the *intercarotic body*, will be found closely applied to the deep surface of the vessel, Fig. 213 (25). The branches of the external carotid which take origin in the area of this triangle run for only a very short part of their course within it. Three branches will be noticed springing from the anterior aspect of the external carotid. Named from below upwards these are: (1) the *superior thyroid*, which, after having given off its *hyoid, superior laryngeal*, and *sterno-mastoid branches*, disappears under cover of the omo-hyoid muscle, and enters the muscular triangle; (2) the *lingual*, which leaves the space by passing under cover of the digastric and stylo-hyoid muscles; and (3) the *facial*, which ascends under the same muscles to gain the digastric triangle. The *occipital artery* commonly springs from the posterior aspect of the external carotid close to the lower border of the digastric, and soon quits the space by running upwards and backwards under cover of the sterno-mastoid muscle. Its *sterno-mastoid branch* comes off as it leaves the triangle, and accompanies the spinal accessory nerve. The *ascending pharyngeal artery* will be found by separating the external and internal carotid arteries from each other, and dissecting between them. It springs from the posterior aspect of the former about half-an-inch above its origin, and then takes a vertical course upwards on the prevertebral muscles.

The *internal jugular vein* lies close to the outer side of the common carotid artery, and is included within the same fascial sheath. Several tributaries join it as it passes through this space. The most conspicuous of these is

the *common facial vein*, which is formed by the union of the facial vein and the anterior division of the temporo-maxillary vein.

The nerves which are brought into view as the carotid triangle is gradually opened up are very numerous, but they can be classified according to the direction which they take through the space. One large nerve, the *hypoglossal*, takes a more or less *transverse* course across the upper part of the space. It forms a loop across this part of the neck immediately below the lower margin of the digastric muscle. Two descend *vertically*—viz., the vagus and the gangliated cord of the sympathetic. The *vagus* lies in the posterior part of the carotid sheath between the common carotid artery and the internal jugular vein. The *sympathetic cord* is embedded in the posterior wall of the carotid sheath. The remaining five nerves traverse the triangle obliquely. Four run from above downwards and forwards, viz., the descendens hypoglossi, the thyro-hyoid, the internal and external laryngeal nerves; and one—the spinal accessory—is directed from above downwards and backwards.

The *descendens hypoglossi* springs from the hypoglossal nerve as it hooks round the occipital artery, and descends within the carotid sheath. It is joined at the upper border of the omo-hyoid by one or two branches from the cervical plexus, and in this manner the *ansa hypoglossi* is formed. The *thyro-hyoid* is a minute nerve which arises from the hypoglossal nerve before it disappears under cover of the posterior belly of the digastric. The *internal laryngeal nerve* descends behind the carotid vessels. It will be readily found, with the corresponding artery, in the interval between the hyoid bone and upper border of the thyroid cartilage. It enters the larynx by piercing the thyro-hyoid membrane. The *external laryngeal nerve*, a branch of the preceding, is a much smaller twig. It leaves the space by passing under cover of the depressor muscles of the larynx and hyoid bone. The *spinal accessory nerve* is placed high up in the interval

between the digastric and the sterno-mastoid muscles. It soon disappears by sinking into the substance of the sterno-mastoid.

The Digastric Triangle may be divided very conveniently into an anterior and posterior part by the stylo-maxillary ligament and a line drawn downwards from it. The portion in front has a distinct floor, composed, in great part, by the mylo-hyoid muscle, and behind this by a portion of the hyo-glossus muscle.

The parts exposed during the dissection of the digastric space may be classified according to the subdivision in which they lie :—

Anterior Part.	Posterior Part.
1. Submaxillary gland.	1. Portion of the parotid gland.
2. Facial artery and vein.	2. External carotid artery.
3. Branches from facial artery in this part of its course. *a.* Ascending palatine. *b.* Tonsillitic. *c.* Submaxillary. *d.* Submental.	3. Posterior auricular artery.
4. Hypoglossal nerve.	
5. Mylo-hyoid nerve.	
6. Mylo-hyoid artery.	
7. Lymphatic glands.	

The most conspicuous object in the fore part of the digastric triangle is the *submaxillary gland.* The *facial artery* passes upwards and forwards in the midst of this gland, whilst the *facial vein* lies superficial to it. But whilst the facial artery runs through the gland, the dissector should note that it can be separated from it without any laceration of the gland lobules. The gland is, as it were, wrapped round it, so that, although at first sight the artery seems to pierce it, it is in reality merely contained in a deep furrow in its substance. Before entering the gland, the facial

artery gives off its *tonsillitic* and *ascending palatine branches*, whilst its *submental* and *submaxillary branches* arise within the gland. The submental artery runs forwards towards the chin. The *mylo-hyoid nerve* and *artery* will be seen passing forwards and downwards upon the mylo-hyoid muscle under cover of the submaxillary gland. The twigs of the nerve to the muscle of the same name and to the anterior belly of the digastric should be followed out. Only a very small part of the *hypoglossal nerve* is seen in this space. It lies upon the hyoglossus muscle immediately above the hyoid bone, and disappears under cover of the posterior border of the mylo-hyoid muscle. Numerous small *lymphatic glands* lie under shelter of the base of the lower jaw.

The *external carotid artery* enters the posterior part of the digastric triangle. Here it lies under cover of the lower part of the parotid gland, and gives off its *posterior auricular branch*, which passes upwards and backwards along the upper border of the posterior belly of the digastric muscle.

Middle Line of the Neck.—Before the parts are further disturbed the dissector should examine the structures which occupy the middle line of the neck—a region, more especially in its lower part, of the highest importance and interest to the surgeon. The middle line of the neck may be divided by means of the hyoid bone into an upper supra-hyoid and a lower infra-hyoid portion.

In the *supra-hyoid part* are found structures which are concerned in the construction of the floor of the mouth. The student has already noticed that the fatty superficial fascia is more fully developed here than elsewhere in the neck, and that the anterior margins of the two platysma muscles meet in the mesial plane about half-an-inch or so below the chin. Above this point their fibres decussate. In the present condition of parts the two anterior bellies of the digastric muscles are observed attached to the mandible

on either side of the symphysis. From this they descend towards the hyoid bone, and diverge slightly from each other so as to leave a narrow triangular space between them (Fig. 214). The floor of this space is formed by the anterior portions of the two mylo-hyoid muscles, whilst bisecting the triangle in the mesial plane is the fibrous raphe, into which these muscles are inserted. Not unfrequently the inner margins of the digastric muscles send decussating fibres across the interval between them.

The *infra-hyoid part* of the middle line of the neck extends from the hyoid bone to the upper margin of the manubrium sterni. Below the hyoid bone is the thyro-hyoid membrane succeeded by the thyroid cartilage with its prominent *pomum Adami*. Then comes the tense crico-thyroid membrane and the cricoid cartilage. Except along a narrow interval on either side of the mesial plane, these structures are covered by two muscular strata, viz., a superficial layer formed by the sterno-hyoid and omo-hyoid which lie on the same plane, and a deeper layer formed by the sterno-thyroid and its continuation upwards, the thyro-hyoid. In addition to these an elongated process of the thyroid gland not unfrequently stretches upwards (usually upon the left side), under cover of the sterno-hyoid. If this be present, it will in all probability be observed to be attached to the hyoid bone by a narrow muscular band termed the *levator glandulæ thyroideæ*. The divergent inner margins of the two small crico-thyroid muscles, as they extend upwards and outwards upon the cricoid cartilage towards the lower margin of the thyroid cartilage, will also be seen. Upon the crico-thyroid membrane, as it appears between these muscles, the small crico-thyroid artery runs transversely inwards.

Below the cricoid cartilage the dissector comes upon the trachea, which extends downwards through the remaining portion of the middle of the neck. As the tube descends it gradually recedes from the surface, so that at the upper

margin of the sternum it lies very deeply. The length of this portion of the trachea varies with the position of the head. When the chin is raised, and the head thrown as far back as possible, about two inches and three-quarters of the tube will be found between the cricoid cartilage and the sternum; when, on the other hand, the head is held in its usual attitude, the length of the cervical part of the

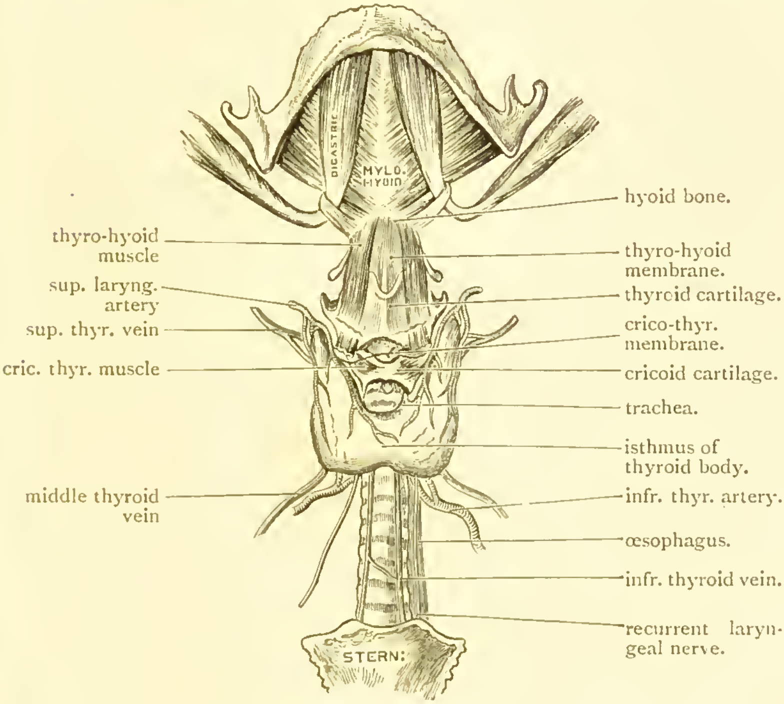

FIG. 214.—Dissection of the middle line of the neck.

trachea is diminished by fully three-quarters of an inch. These measurements must be regarded as merely expressing the average condition. They vary considerably in different individuals, and are much influenced by differences in the length of the neck.

The dissector must study carefully the parts which lie superficial to the trachea in this portion of its course. In

the first place, examine the structures which are in immediate contact with it. These are (1) the isthmus of the thyroid body; (2) the inferior thyroid veins; (3) at the root of the neck, the innominate artery and the left innominate vein; (4) the thymus body in young children; and (5) the occasional thyroidea ima artery. The *isthmus of the thyroid* is a thin band of thyroid substance which crosses the mesial plane upon the anterior aspect of the trachea. As a general rule it covers the second, third, and fourth tracheal rings, so that only one ring is left exposed between its upper margin and the cricoid cartilage. Almost invariably a branch of the superior thyroid artery runs along the upper margin of the isthmus, whilst upon its anterior surface is placed a plexiform arrangement of small veins. The *inferior thyroid veins* are two in number, and of large size. They are formed by several tributaries which issue from the lateral lobes, and proceed downwards upon the front of the trachea, one upon either side of the mesial plane. They are separated from each other by a narrow interval, and immediately below the isthmus they are connected by a plexus of small veins which lies in front of the trachea. An additional *median vein*, taking origin from the isthmus, may also exist. Close to the sternum the *innominate artery* will be observed lying upon the trachea, and slightly below the level of the upper border of the bone *the left innominate vein* crosses it. The *thymus body* in children of two years or under is always prolonged upwards for some distance into the neck in front of the trachea. The *thyroidea ima* is an occasional branch of the innominate artery. When present it passes vertically upwards in front of the trachea to the isthmus of the thyroid gland.

The parts which separate the trachea, with the structures in immediate relation to its anterior aspect, from the surface should now be studied. The two anterior jugular veins as they run downwards in the superficial fascia, one upon either side of the mesial plane, have been already

noticed; also, the two layers of the deep cervical fascia close to the upper margin of the sternum, and in the interval between these the cross-branch connecting the two anterior jugular veins. Behind the fascial envelope of the neck come the two muscular strata formed by the sterno-hyoid and the sterno-thyroid muscles. The inner margins of the sterno-hyoid muscles are almost contiguous above, and held together by the fascial sheaths which enclose them; below, however, they diverge slightly from each other, so as to expose, close to the sternum, the inner margins of the sterno-thyroid muscles. The sterno-thyroid muscles, in contact with each other below, gradually separate from each other as they ascend. A narrow, lozenge shaped space is thus left between the inner borders of these muscles. Over this area, the trachea is not covered by any muscular structure.

Surgical Anatomy.—The principal operations which are performed in the middle line of the neck are those of laryngotomy and tracheotomy.

In laryngotomy, an opening is made into the larynx. This can most readily be done in the interval between the thyroid and cricoid cartilages. A vertical mesial incision through the integument is made over this interval. The crico-thyroid membrane is thus exposed, and is divided *transversely* close to the upper margin of the cricoid cartilage. It is a very simple proceeding, and one which is attended with little or no danger if ordinary care be taken. The crico-thyroid membrane is divided transversely, and in its lower part, for two reasons—viz. (1) to avoid injury to the crico-thyroid artery, which, although, as a general rule, of small size and of no surgical importance, is sometimes large enough to give rise to awkward results if wounded; and (2) to place the opening as low down as possible.

Tracheotomy is a more serious operation. The opening into the trachea may be made above or below the isthmus of the thyroid body. The *high operation* is very properly preferred by the surgeon. Its advantages are very apparent: here the trachea lies near the surface, and no veins of any importance are met with. The only drawback consists in the small portion of trachea which intervenes between the isthmus and the cricoid cartilage. Still, this can be increased by pushing down the isthmus, which, within certain limits, can be easily dislodged in a downward direction. Many surgeons, indeed, consider that the wounding of the isthmus is a matter of comparatively slight

importance. The fact, however, that a large branch of the superior thyroid artery is generally found in relation to its upper border, should make the operator hesitate before having recourse, in all cases, to this expedient for gaining additional space. In the child it is frequently necessary to combine the high operation of tracheotomy with that of laryngotomy—viz., by cutting through the cricoid cartilage.

The *low operation* is a formidable undertaking. It is true that there is a greater length of tube to be operated upon; but this is situated very deeply, and the surgeon encounters many difficulties before it is reached. If the dissector reflect upon the structures which intervene between this part of the trachea and the surface, he will fully realise this; and he must bear in mind that these difficulties are greatly intensified in the living subject by the engorged state of the veins, and the convulsive movements of the windpipe as the patient struggles for breath. In the child, the thymus body interposes an additional obstacle; and this, combined with the more limited space, the small calibre and great mobility of the trachea, render the operation, in such cases, a very serious responsibility. In the low operation, the trachea must be opened in an upward direction, so as to avoid injury to the innominate artery and left innominate vein, which are placed in front of it at the upper margin of the sternum.

Infra-hyoid Muscles.—These are a series of flat, narrow, band-like muscles which lie upon the trachea, thyroid body, and larynx. They are disposed in two strata—viz., the omo-hyoid and the sterno-hyoid constituting a superficial layer; and the sterno-thyroid and thyro-hyoid a deep layer.

The *omo-hyoid* (omohyoideus), as we have noted, is a two-bellied muscle. The *posterior belly* springs from the upper border of the scapula and the suprascapular ligament. It crosses the posterior triangle of the neck, so as to divide it into an occipital and supraclavicular portion, and finally terminates in the intermediate tendon. This tendon lies under cover of the sterno-mastoid muscle, and is held in position by a strong process of fascia derived from the cervical aponeurosis, and firmly attached below to the sternum and the first costal cartilage. The *anterior belly* emerges from under cover of the anterior border of the sterno-mastoid, and takes an almost vertical course through the anterior triangle. It is inserted into the lower border

of the body of the hyoid bone, close to the outer side of the sterno-hyoid. In the anterior triangle of the neck, the anterior belly of the omo-hyoid forms the boundary between the carotid and the muscular subdivisions of this area.

The *sterno-hyoid* (sternohyoideus) arises from the posterior aspect of the inner end of the clavicle and the posterior sterno-clavicular ligament. Its origin, however, is very variable; thus, it may be shifted either inwards or outwards. In the former case, it springs from the baek of the manu-

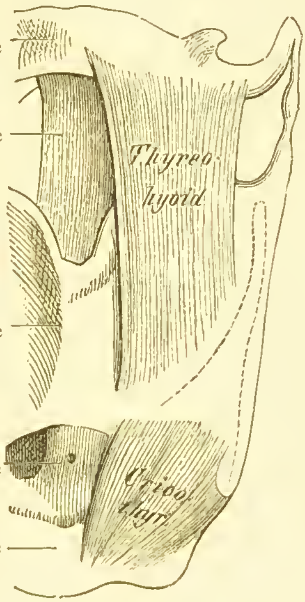

FIG. 215.—Hyoid bone and larynx. (GEGENBAUR).

brium sterni and the ligament; in the latter case, from the clavicle alone. It is inserted into the lower border of the body of the hyoid bone, between the mesial plane and the insertion of the omo-hyoid. A short distanee above the sternum an oblique fibrous interscction frequently divides it into two portions.

The *sterno-thyroid* (sternothyreoideus) lics undcr cover of the preeeding musele, and is both broader and shortcr.

It springs from the posterior aspect of the manubrium sterni and from the cartilage of the first rib. Diverging slightly from its neighbour as it ascends, it is inserted into the oblique line on the outer face of the ala of the thyroid cartilage. An incomplete tendinous intersection may sometimes be noticed interrupting its muscular fibres.

The *thyro-hyoid* (thyreohyoideus) lies on the same plane as the sterno-thyroid; indeed, it may be regarded as its continuation upwards. It takes origin from the oblique line on the thyroid ala, and is inserted into the lower border of the body and a part of the great cornu of the hyoid bone under cover of the sterno-hyoid and omo-hyoid muscles.

Digastric Muscle (digastricus).—This muscle limits the submaxillary triangle inferiorly, and intervenes between it and the carotid triangle.

The *anterior belly of the digastric* springs from an impression upon the deep aspect of the base of the mandible, close to the symphysis, whilst the *posterior belly* takes origin from the digastric fossa of the temporal bone under cover of the mastoid process. Both bellies converge as they proceed towards the upper border of hyoid bone, where they are joined by a strong round *intermediate tendon*. The posterior belly is the longer of the two, and is fusiform in shape; the anterior belly is shorter and flatter, and descends in a more vertical direction. The intermediate tendon is bound down to the great cornu and the body of the hyoid bone by a strong aponeurotic band.

Stylo-Hyoid Muscle (stylohyoideus).—The stylo-hyoid muscle lies along the upper border of the posterior belly of the digastric. It is a small muscular band which arises from the posterior aspect of the styloid process of the temporal bone not far from its base. It is generally inserted by two slips into the hyoid bone at the point where the great cornu joins the body. The intermediate tendon of the digastric passes forwards between the two slips of insertion of the stylo-hyoid.

Hypoglossal Nerve.—The portion of the hypoglossal nerve which traverses the anterior triangle can be studied at this stage. It appears by emerging from under cover of the posterior belly of the digastric, and immediately turns forwards by hooking round the occipital artery. Near the upper border of the hyoid bone it disappears from the present dissection by passing under cover of the mylo-hyoid muscle. It forms a loop on the side of the neck which lies upon the external carotid and lingual arteries and finally, above the hyoid bone, upon the hyoglossus muscle. It is crossed by the intermediate tendon of the digastric and the two slips of insertion of the stylo-hyoid.

Two branches will be seen to arise from this portion of the hypoglossal nerve, viz.:—

1. The ramus descendens.
2. The thyro-hyoid.

The *ramus descendens hypoglossi*, as a rule, leaves the hypoglossal nerve at the point where it turns round the occipital artery. It proceeds downwards and inwards so as to cross the common carotid artery very obliquely. Reaching the upper border of the anterior belly of the omo-hyoid, it ends by joining a slender branch which advances towards it from the second and third cervical nerves. This nerve is called the *ramus cervicalis descendens* and by its union with the ramus descendens hypoglossi a nerve-loop is formed in front of the common carotid artery, which is called the *ansa hypoglossi* (Fig. 218).

From the convexity of this loop branches are given off which supply both bellies of the omo-hyoid, the sterno-hyoid, and sterno-thyroid muscles.

The branches for the anterior belly of the omo-hyoid may proceed from the ramus descendens hypoglossi before it reaches the ramus cervicalis descendens. The filament for the posterior belly runs downwards and backwards along the lower border of the intermediate tendon, and between

the two laminæ of the fascial sheath which retains the tendon in position. The branch for the sterno-hyoid and sterno-thyroid muscles is a nerve which breaks up along their outer margins into a number of twigs for their supply. One small filament may sometimes be traced into the thorax, where it communicates with the phrenic and cardiac nerves.

The *thyro-hyoid nerve* is a slender twig which comes off from the hypoglossal as it approaches the hyoid bone. It supplies the thyro-hyoid muscle.

Sterno-Clavicular Articulation.—The dissector must now examine the sterno-clavicular joint, as the next step consists in the disarticulation of the clavicle and the reflection of the clavicular origin of the sterno-mastoid muscle.

The structures which hold the two bones in position at this joint are the following :—

Ligaments proper.	Anterior sterno-clavicular. Posterior sterno-clavicular.
Accessory ligaments.	Interclavicular. Costo-clavicular or rhomboid.
Interarticular fibro-cartilage.	

Dissection.—To expose these ligaments the origin of the pectoralis major from the clavicle and the manubrium sterni must be removed. The sternal origin of the sterno-mastoid is also, to a certain extent, in the way, but it is not advisable to divide this.

Sterno-Clavicular Ligaments.—These are placed one in front and the other behind the joint, but they are not isolated sharply-defined bands. Above, they are united by their margins with the interclavicular ligament, whilst below they run into each other so as to constitute in this manner a capsule for the joint (capsula articularis). The *anterior sterno-clavicular ligament* springs from the front of the inner end of the clavicle, and proceeds obliquely downwards and inwards to gain attachment to the anterior aspect of the manubrium sterni. The *posterior sterno-clavicular ligament* has a corresponding position, and presents similar attachments on the posterior aspect of the joint.

These ligaments limit the backward and forward movements of the inner end of the clavicle, upon the sternal facet.

The Interclavicular Ligament (ligamentum interclaviculare) is a strong band which connects the inner ends of the two clavicles. It is firmly fixed to the upper edge of each bone, and as it passes across the middle line it dips into the notch on the upper margin of the sternum, and is attached to it also.

The Rhomboid Ligament (ligamentum costoclaviculare) is composed of short oblique fibres. It is placed behind the subclavius muscle, the remains of which must therefore be removed to expose its anterior surface; at the same time the clavicle must be tilted upwards as high as possible. The rhomboid ligament is attached by its lower border to the cartilage of the first rib. From this it is carried obliquely upwards, backwards, and outwards, and is fixed by its upper border to a rough depression upon the under surface of the inner end of the clavicle.

The rhomboid ligament plays an important part in the mechanism of the joint, and adds greatly to its security. It checks excessive elevation of the shoulder, and restrains, within certain limits, both forward and backward movement of the clavicle.

Dissection.—The interarticular fibro-cartilage is the most important of all the agents concerned in maintaining the apposition of the inner end of the clavicle with the sternum. To obtain a view of this structure, the joint must be opened into; indeed, it is well to remove as far as possible all the ligaments. Begin by dividing the rhomboid ligament. To effect this the clavicle must be raised and the knife carried inwards between its inner end and the first costal cartilage. Next remove the interclavicular and anterior and posterior sterno-clavicular ligaments. It is difficult to get at the posterior sterno-clavicular ligament in the present condition of parts, but with a little care the sterno-hyoid muscle may be detached from its surface, and its fibres divided. The clavicle should now be forcibly pulled outwards, when the interarticular fibro-cartilage will become apparent.

The Interarticular Fibro-Cartilage (discus articularis) is a nearly circular meniscus or plate interposed between the inner end of the clavicle and the sternal facet. Its surfaces are accurately moulded upon both. As a general rule it is thicker around its circumference than in the centre, where it is occasionally perforated. In removing the capsule of the joint, the dissector must have noticed that by its circumference it is closely attached to this, both in front and behind. *Above*, it is firmly fixed to the upper edge of the inner end of the clavicle; *below*, its margin is thinned and passes outwards under the clavicle to gain attachment to the inner end of the cartilage of the first rib.

The part which the interarticular meniscus plays is very apparent. Its function is twofold; (1) it acts as a cushion, and thus lessens the shock of blows received upon the shoulder; (2) it acts as a bond of union, and prevents the clavicle from being driven upwards upon the top of the sternum when force is applied to its outer end.

Synovial Membranes.—The sterno-clavicular joint is provided with two synovial membranes, placed one upon either side of the interarticular fibro-cartilage. These are quite distinct from each other, except in cases where the fibro-cartilage is deficient in its centre. In this case the two synovial cavities communicate.

Dissection.—Complete the disarticulation of the clavicle by dividing the attachment of the fibro-cartilage to the first costal arch. By this step the meniscus is removed with the clavicle, and can therefore be more fully examined. Further, the clavicular portion of the sterno-mastoid can now be thrown forward, and the parts under cover of this muscle dissected. The sternal origin of the sterno-mastoid should not be interfered with until the subclavian and carotid vessels have been studied.

Certain structures at the root of the neck must now be displayed. These are:—

1. The scalene muscles.
2. The phrenic nerve.
3. The subclavian vessels and their branches.
4. The cervical pleura.

5. The thoracic duct on the left side, and the right lymphatic duct on the right side.
6. The lower part of the internal jugular vein.
7. The vagus nerve.
8. The lower part of the common carotid artery.
9. The lower part of the cervical sympathetic.

As the dissection is proceeded with, a large number of important structures will be observed grouped in relation to the scalenus anticus muscle. Thus it is crossed *in front* and from below upwards by—(1) the subclavian vein, which lies upon its insertion into the first rib ; (2) the suprascapular artery ; (3) the transversalis colli artery ; and (4) the omo-hyoid muscle, with the nerve to its posterior belly. Under cover of these, the phrenic nerve is carried downwards upon the anterior aspect of the muscle, whilst the thoracic duct on the left side, and the right lymphatic duct on the right side, lie for a short distance in front of it, near its inner margin. Both of these ducts open into the venous system at the angle of union between the internal jugular and subclavian veins. *Behind* the scalenus anticus, the cervical pleura bulges upwards for a short distance into the neck, and at a higher level the subclavian artery and the brachial nerves are also in relation to its posterior surface. Close to its *inner margin*, are the thyroid axis, the vertebral artery and vein, and somewhat overlapping it, the large internal jugular vein ; whilst ascending in the interval between the scalenus anticus and the rectus capitis anticus major, is the small ascending cervical artery.

Between the scalenus anticus and the trachea will be found the internal jugular vein, the vagus nerve, common carotid artery, the first part of the subclavian artery with its branches, and the sympathetic cord.

This is a tedious dissection, on account of the numerous twigs which are given off by the sympathetic. Certain of these descend in relation to the first part of the subclavian artery, and must be carefully preserved. The middle cervical ganglion, as a general rule, rests upon the inferior thyroid artery, whilst the lowest ganglion in the neck is placed in the depression between the transverse process of the last cervical vertebra and the neck of the first rib.

Scalene Muscles.—These muscles constitute the fleshy mass which is seen extending from the transverse processes of the cervical vertebræ to the upper two costal arches. They are three in number, and are named, from their relative positions, *anticus*, *medius*, and *posticus*.

The *scalenus anticus* (scalenus anterior) is a well-defined muscle which is separated from the scalenus medius by the brachial nerves and the subclavian artery. It arises from the anterior tubercles of the transverse processes of four cervical vertebræ—viz., the third, fourth, fifth, and sixth—and, tapering somewhat as it descends, is inserted into the scalene tubercle on the inner margin of the first rib, and also into the upper surface of the same bone between the two subclavian grooves.

The *scalenus medius* is a more powerful muscle than the preceding. It springs from the posterior tubercles of all the cervical transverse processes (with the exception, in some cases, of the first), and it is inserted into a rough oval elevation which marks the upper surface of the first rib between the tubercle and the groove for the subclavian artery.

The *scalenus posticus* (scalenus posterior) is generally inseparable at its origin from the scalenus medius. It is the smallest of the three, and springs by two or three slips from the transverse processes of a corresponding number of the lower cervical vertebræ in common with the scalenus medius. It is inserted into the upper border of the second rib, immediately in front of the insertion of the levator costæ.

Subclavian Artery (arteria subclavia).—The subclavian artery is the first subdivision of the great vessel which carries blood for the supply of the upper limb. It arises differently on the two sides of the body. On the *right side* it takes origin behind the sterno-clavicular articulation by the bifurcation of the innominate artery. On the *left side* it springs, within the cavity of the thorax, from the aortic arch. In both cases it takes an arched course outwards across the root of the neck, behind the scalenus anticus muscle and above the pleura. At the outer border of the first rib it enters the axilla and receives the name of axillary artery.

The relations of the subclavian artery are so numerous, and of so varied a character, at different parts of its extent, that it is found necessary to subdivide it into three portions. The *first part* extends from the origin of the vessel to the inner margin of the scalenus anticus; the *second portion* lies behind this muscle; whilst the *third part* extends from the

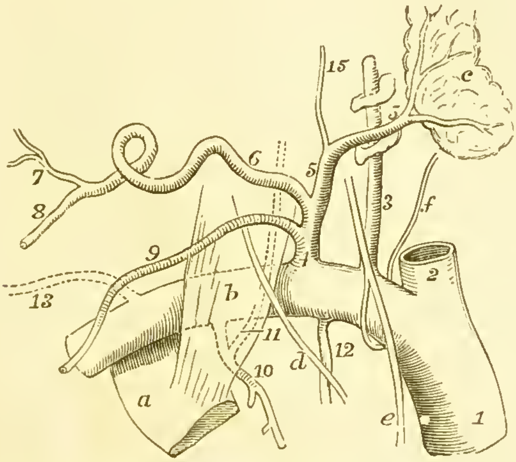

FIG. 216.—Diagram of the subclavian artery and its branches. (TURNER.)

1. Innominate artery.
2. Common carotid artery.
3. Vertebral artery.
4. Thyroid axis.
5. Inferior thyroid artery.
6. Transversalis colli.
7. Superficial cervical.
8. Posterior scapular.
9. Suprascapular.
10. Superior intercostal.
11. Deep cervical.
12. Internal mammary.
13. Posterior scapular.
15. Ascending cervical.

a. First rib.
b. Scalenus anticus.
c. Thyroid body.
d. Phrenic nerve.
e. Vagus nerve.
f. Recurrent laryngeal.

outer border of the scalenus anticus to the outer border of the first rib.

First part.—Owing to the difference of origin, the relations presented by the first portion of the subclavian artery are not the same on the two sides of the body. Let us examine, in the first instance, the vessel of the right side,

and then compare it with that of the left side. The first part of the *right subclavian* extends obliquely upwards and outwards, and at its termination, at the inner margin of the scalenus anticus, it has reached a point above the level of the clavicle. It is placed very deeply. *In front*, it is covered by the skin, superficial fascia, platysma, deep fascia, and three muscular strata—viz., the clavicular origin of the sterno-mastoid, the sterno-hyoid, and the sterno-thyroid. Three veins and some nerves are also placed in front of it. Thus, it is crossed by the internal jugular and vertebral veins, as these proceed from above downwards, whilst the anterior jugular vein, as it passes outwards under cover of the sterno-mastoid, is separated from it by the sterno-hyoid and sterno-thyroid muscles. The nerves which cross it are the vagus, with one or two cardiac branches as they run towards the thorax, and a loop from the sympathetic. As the vagus nerve leaves the artery it gives off its recurrent branch.

The first part of the subclavian artery presents most important relations to the pleura. The cervical dome of this membrane bulges upwards behind it so that the vessel rests upon its anterior surface a short distance from its summit. The sympathetic cord passes downwards behind the artery, and the recurrent laryngeal branch of the vagus nerve hooks round it, and is thus related to it both below and behind.

Immediately below the first part of the subclavian, and upon a more anterior plane, the right innominate vein is formed by the union of the internal jugular and subclavian trunks.

On *the left side*, the first part of the subclavian ascends almost vertically from its origin from the aortic arch, and reaching the root of the neck, turns abruptly outwards upon the pleura to gain the inner margin of the scalenus anticus. It is only with that portion of the vessel which lies in the root of the neck that we are concerned at present. Its

relations are somewhat different from those on the right side. The same fascial and muscular layers, and the same nerves and veins, lie in front of it. Owing to its different direction, however, the latter are placed more or less parallel to it. Three additional relations are established—viz. (1) the phrenic nerve, which descends in front of it; (2) the left innominate vein, which crosses it; and (3) the thoracic duct, which first passes upwards in relation to its inner side, and then arches over it to reach the angle of junction between the subclavian and internal jugular veins.

The recurrent laryngeal nerve, which on this side hooks round the arch of the aorta, lies to the inner side of the subclavian artery.

Second part.—The second portion of the subclavian artery forms the highest part or summit of the arch. From half-an-inch to an inch above the level of this bone is the average height to which the subclavian artery rises in the neck. In some cases, however, it may reach higher, whilst in others it is placed at a lower level—indeed, it may not extend above the clavicle at all.

In this part of its course the vessel is not so deeply placed. *In front* it is covered by—(1) skin; (2) superficial fascia and platysma; (3) deep fascia; (4) clavicular head of the sterno-mastoid; (5) scalenus anticus. The phrenic nerve on the right side is also an anterior relation. It passes downwards in front of the vessel, but separated from it by the inner margin of the scalenus anticus. *Behind and below*, the vessel is in contact with the pleura. The subclavian vein lies at a lower level and in front of the artery. It is separated from the artery by the scalenus anticus, which intervenes between the two vessels.

The *third part* of the subclavian artery has already been examined (p. 204).

Branches of the Subclavian Artery.—Four branches spring from the subclavian trunk. In this respect, however, the vessel is subject to considerable variation. They all

take origin, as a general rule, close together; three proceeding from the first part of the artery close to the scalenus anticus, and one from the second part. They are—

From the *first part.*	1. Vertebral.	
	2. Thyroid axis.	Inferior thyroid. Transversalis colli. Supra-scapular.
	3. Internal mammary.	
From the *second part.*	Superior intercostal.	Superior intercostal proper. Deep cervical.

In a great number of cases, a branch of considerable size will be observed springing from the third part of the subclavian artery. This, in all probability, will be the posterior scapular arising directly from the subclavian. It is so common an occurrence that the dissector must always be prepared to meet it.

Vertebral Artery (arteria vertebralis).—This is the first branch which is given off by the subclavian. It springs from the posterior aspect of the trunk about a quarter of an inch from the inner margin of the scalenus anticus on the right side, and from the point where the vessel reaches the root of the neck on the left side. Only a small portion of its extent is seen in the present dissection. It proceeds upwards in the interval between the longus colli and the scalenus anticus muscles, and disappears by entering the foramen transversarium of the transverse process of the sixth cervical vertebra. It is placed very deeply, and is covered in front by its companion vein and the internal jugular vein. Numerous large sympathetic twigs accompany it.

The vertebral artery on the *left side* is crossed by the thoracic duct.

The *vertebral vein* will be noticed issuing from the aperture in the transverse process of the sixth cervical vertebra. It passes downwards in front of its companion artery, and behind the internal jugular vein, to open into

the posterior aspect of the commencement of the corresponding innominate vein. Near its termination it crosses the subclavian artery. It receives the *deep cervical* and the *anterior vertebral veins.*

Thyroid Axis (truncus thyreocervicalis).—This is a short wide trunk, which arises from the front of the subclavian artery, close to the inner margin of the scalenus anticus, and under cover of the internal jugular vein. It lies between the phrenic and pneumogastric nerves, and almost immediately breaks up into its three terminal branches—viz., the inferior thyroid, the suprascapular, and the transversalis colli.

The Inferior Thyroid Artery (arteria thyreoidea inferior) takes a sinuous course to reach the thyroid body. At first, it ascends for a short distance upon the vertebral artery, and under cover of the internal jugular vein; then it turns suddenly downwards and inwards, and passes behind the sympathetic and the common carotid artery; lastly, it bends upwards, and ends in branches at the base of the lateral lobe of the thyroid body.

The following branches will be noticed arising from the inferior thyroid artery :—

1. Ascending cervical.	4. Œsophageal.
2. Inferior laryngeal.	5. Thyroid.
3. Tracheal.	6. Muscular.

The *ascending cervical artery* (arteria cervicalis ascendens) is a small but very constant vessel, which runs upwards in the interval between the scalenus anticus and rectus capitis anticus major, and dispenses branches to the muscles in front of the vertebral column. Other twigs from the ascending cervical, termed *spinal branches*, enter the spinal canal upon the spinal nerves, and anastomose with branches from the vertebral artery. The ultimate distribution of the spinal branches has already been noticed (pp. 166 and 179).

The *inferior laryngeal artery* (arteria laryngea inferior) is a small vessel which accompanies the recurrent laryngeal

nerve to the larynx. The *tracheal* (rami tracheales) and *œsophageal* (rami œsophagei) *branches* in like manner supply the trachea and gullet. They are of small size, and anastomose with the bronchial and œsophageal branches of the thoracic aorta. The *thyroid* or *terminal branches* (rami glandulares) are usually two in number. One ascends upon the posterior aspect of the lateral lobe of the thyroid body, whilst the other is given to its base or lower end. They inosculate with the corresponding vessels of the opposite side, and also with the branches of the superior thyroid artery. The *muscular branches* are a series of irregular twigs given to the various muscles in the neighbourhood.

The *inferior thyroid vein* does not run in company with the artery of the same name. It is a large vessel which comes from the lateral lobe of the thyroid body, and descends upon the trachea under cover of the sterno-thyroid muscle. The veins of both sides enter the thorax, and unite to form a short common stem, which opens into the left innominate trunk. In many cases, however, the right vein will be observed to open separately into the angle of union between the two innominate veins. Both veins receive, as they proceed down, tributaries from the larynx, trachea, and œsophagus.

The *anterior vertebral vein* accompanies the ascending cervical artery, and opens into the vertebral vein.

The Suprascapular and Transversalis Colli Arteries have already been examined in the greater part of their course (p. 206). After taking origin from the thyroid axis, they both pass outwards upon the scalenus anticus muscle, and under cover of the clavicular head of the sterno-mastoid. The *suprascapular* (arteria transversa scapulæ) crosses the scalene muscle close to its insertion, immediately above the subclavian vein; the *transversalis colli* (arteria transversa colli) is placed at a slightly higher level. Both vessels cross in front of the phrenic nerve.

The *supra-scapular* and *transversalis colli veins* have already been seen joining the subclavian or the external jugular vein.

The Internal Mammary Artery (arteria mammaria interna) springs from the lower aspect of the subclavian opposite the thyroid axis. It proceeds downwards upon the anterior surface of the pleura and behind the inner end of the clavicle, to reach the thoracic cavity. In the cervical part of its course, it will be observed to pass behind the subclavian vein, and to be crossed from without inwards by the phrenic nerve. In the neck, the internal mammary artery is accompanied by no companion vein.

Superior Intercostal Artery (truncus costocervicalis).—This branch takes origin from the posterior aspect of the second portion of the subclavian artery, close to the inner border of the scalenus anticus. On the left side, however, it, as a rule, proceeds from the first part of the parent trunk. To bring it into view, the subclavian artery must be dislodged from its position. It is a short trunk which passes backwards and slightly upwards, and almost immediately divides into the *deep cervical artery* and the *superior intercostal artery proper.*

The *deep cervical artery* (arteria cervicalis profunda) passes backwards, and disappears from view between the transverse process of the seventh cervical vertebra and the neck of the first rib. It has been already noticed in the dissection of the back of the neck (p. 154).

The *superior intercostal artery* (arteria intercostalis suprema) turns downwards over the neck of the first rib, close to the outer side of the sympathetic cord, and ends in the thorax by giving branches to the upper two intercostal spaces.

The *deep cervical vein* is a large vessel. It joins the vertebral vein.

The Subclavian Vein (vena subclavia) is the continuation of the axillary vein into the root of the neck. It begins,

therefore, at the outer border of the first rib, and arches inwards in front of the scalenus anticus muscle close to its insertion. At the inner margin of this muscle it joins the internal jugular to form the innominate vein. In connection with the subclavian vein, note: (1) that the arch which it forms is not so pronounced as in the case of the corresponding artery; (2) that throughout its whole course it lies at a lower level, and upon a plane anterior to the artery, and (3) that it is separated from the artery by the scalenus anticus and the phrenic nerve.

The *tributaries* of the subclavian vein are (1) the external jugular vein, and (2) in some cases the anterior jugular vein. These join it at the outer margin of the scalenus anticus muscle (Fig. 217).

Thoracic and Right Lymphatic Ducts.—The *thoracic duct* is the vessel by means of which the lymph and chyle, derived from by far the greater part of the body, is poured into the venous system on the left side. Its terminal or cervical portion is displayed in the present dissection. It is a small delicate vessel, frequently mistaken for a vein, which enters the root of the neck upon the left side of the œsophagus. It is here, therefore, that it should be sought. When it reaches the level of the seventh, or perhaps the sixth cervical vertebra, it changes its course and arches outwards and forwards, and then downwards upon the apex of the pleura, to gain the outer margin of the internal jugular vein at its angle of union with the subclavian, and into this it opens. As the thoracic duct courses outwards, it is placed at a higher level than the subclavian artery, and passes behind the internal jugular vein. Further, as it approaches the point at which it ends it crosses the first part of the subclavian artery.

A valve composed of two segments guards its orifice into the jugular vein. This allows its contents to flow freely into the vein, but acts as a barrier to the passage of venous blood into the duct.

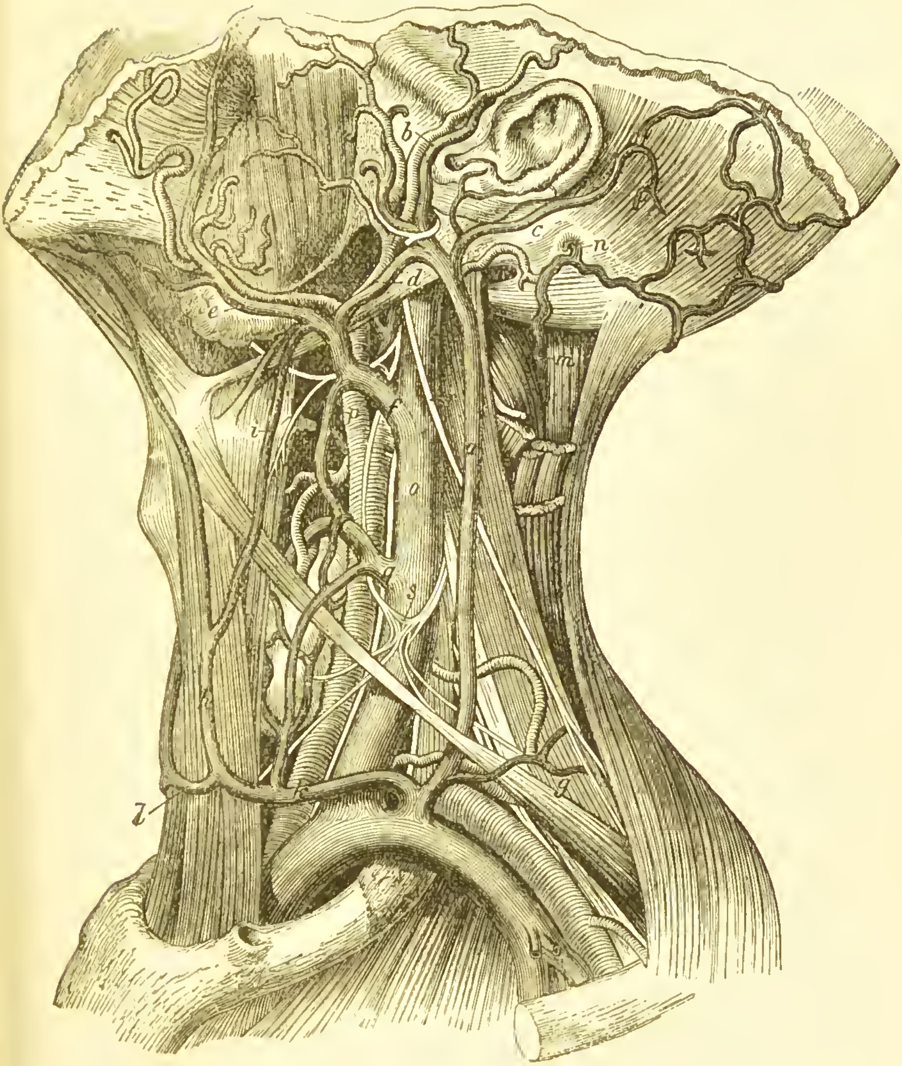

FIG. 217.—Dissection of the neck. The sterno-mastoid and the inner half of the clavicle have been removed.—(LUSCHKA.)

a. External jugular vein.
b. Temporal vein.
c. Posterior auricular vein.
d. Anterior temporo-maxillary vein.
e. Facial vein.
f. Common facial vein.
g. Transversalis colli vein.
h. Anterior jugular vein.
i. Communicating branch between anterior jugular and facial veins.
k. The part of the anterior jugular which turns horizontally outwards under cover of the sterno-mastoid.
l. Transverse communication between the two anterior jugular veins.
m. Deep cervical vein.
n. Mastoid emissary vein.
o. Internal jugular vein.
p. Superior thyroid vein.
r. Spinal accessory nerve.
s. Ansa hypoglossi.

The *right lymphatic duct* is the corresponding vessel upon the right side. It is a very insignificant duct, and draws its supply of lymph from a much more restricted field. In length it rarely measures more than half-an-inch. It will be found at the inner margin of the scalenus anticus opening into the angle of union between the internal jugular and subclavian veins of the right side. As in the case of the thoracic duct, its orifice is guarded by a double valve.

Cervical Pleura.—The pleural sac of each side, with the apex of the corresponding lung, projects upwards into the root of the neck, and the dissector should now examine the height to which it rises, and the connections which it establishes. Its height varies in different subjects. In some cases it extends up for two inches above the sternal end of the first rib; in others for not more than one inch. It forms a dome-like roof for each side of the thoracic cavity, and is strengthened by a fascial expansion (frequently termed *Sibson's fascia*) which covers it completely, and is attached on the one hand to the transverse process of the seventh cervical vertebra and on the other to the inner margin of the first rib. Observe, further, that the cervical pleura is supported above by the scalene muscles, under cover of which it ascends into the neck, and that the subclavian artery arches outwards upon its anterior surface near its apex.

Cervical Plexus (Fig. 218).—This plexus is formed by the anterior primary divisions of the upper four cervical nerves. These nerves are much smaller than the lower cervical nerves which form the brachial plexus, and they have only a short course to run as independent trunks. With the exception of the first, each divides into an ascending and a descending branch, and these joining with each other, constitute the plexus, which, therefore, consists of three loops. The descending branch of the fourth nerve which is very small proceeds downwards to unite with the fifth nerve, and thus establish a connection with the brachial plexus.

The cervical plexus thus formed has very definite relations. It lies under cover of the upper part of the sterno-mastoid

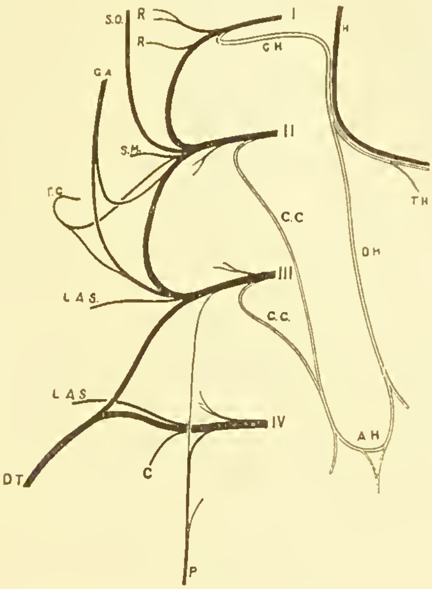

FIG. 218.—Diagram of the cervical plexus and the ansa hypoglossi.

I., II., III., IV.—Anterior primary divisions of the upper four cervical nerves.

R. Branches to recti muscles.
G.A. Great auricular.
S.M. Branches to the sterno-mastoid.
S.O. Small occipital.
T.C. Superficial cervical.
L.A.S. Branches to levator anguli scapulæ.
D.T. Descending trunk.
C. Communicating to fifth cervical.
P. Phrenic.
C.C. Rami communicantes hypoglossi.
C.H. Communicating branch to hypoglossal.
H. Hypoglossal.
T.H. Thyro-hyoid nerve.
D.H. Descendens hypoglossi.
A. H. Ansa hypoglossi.

This diagram shows that the descendens hypoglossi, the branch to the thyro-hyoid, and in all probability the branches to the genio-hyoid, are composed of fibres given to the hypoglossal by the communicating twigs it receives from the first cervical nerve.

and in front of the scalenus medius and the levator anguli scapulæ muscles.

Its branches are very numerous, and may be classified in the following manner :—

Superficial or Cutaneous.	Ascending.	Small occipital.	From 2nd.
		Great auricular.	From 2nd & 3rd.
	Transverse.	Superficial cervical.	
	Descending.	Supraclavicular.	From 3rd & 4th.
		Suprasternal.	
		Supra-acromial.	
Deep.	Muscular.	1. To rectus capitis anticus major.	From 1st & 2nd.
		2. To rectus capitis anticus minor.	
		3. To rectus capitis lateralis.	
		4. To sterno-mastoid.	From 2nd.
		5. Ramus cervicalis descendens (rami communicantes hypoglossi).	From 2nd & 3rd.
		6. To levator anguli scapulæ.	From 3rd & 4th.
		7. To scalenus medius.	
		8. To trapezius.	
		9. Phrenic to diaphragm.	From 4th & 5th.
	Communicating.	1. To hypoglossal.	From 1st.
		2. To vagus.	
		3. To sympathetic.	From 1st, 2nd, 3rd, & 4th.
		4. To spinal accessory.	From 2nd, 3rd, & 4th.

The *superficial branches* have already been examined, but now that the plexus is fully dissected, the student should again study their mode of origin.

Muscular Branches.—The *anterior recti muscles* and the *rectus lateralis* receive twigs from the first loop of the plexus, but as this is placed very high up in the neck, these branches can only be satisfactorily displayed in the deep dissection of the neck. The *sterno-mastoid muscle* draws one or more twigs from the second cervical nerve, and by means of these

a communication is effected with the spinal accessory nerve, which pierces, and at the same time supplies filaments to the muscle. The *levator anguli scapulæ* always receives two or three branches from the third and fourth nerves, whilst the *scalenus medius* obtains its nerve supply from the same nerve-trunks before these have entered the plexus. The branches to the *trapezius* come off in common with the trunk which divides into the descending superficial nerves, and are therefore derived from the third and fourth nerves. Upon the under surface of the trapezius, these branches unite with the spinal accessory, and form the *sub-trapezial plexus.*

The *ramus cervicalis descendens* is formed by the union of two long slender roots (rami communicantes hypoglossi) which spring from the second and third nerves respectively. It proceeds downwards and inwards under cover of the sterno-mastoid, and either behind or in front of the internal jugular vein, to join the ramus descendens hypoglossi and form the ansa hypoglossi. In some cases the two roots of the descendens cervicalis remain separate throughout all their course.

The *phrenic nerve* is the most important branch given off by the cervical plexus. It springs from the fourth cervical nerve, and as a rule obtains also a root from the fifth or the third cervical nerve, or perhaps from both. If the root from the fifth nerve fails, the phrenic will in all probability be found to receive lower down a twig from the nerve to the subclavius. The course which the phrenic pursues in the neck is so definite, that there should never be any difficulty in recognising this nerve. It descends, inclining at the same time inwards, in front of the scalenus anticus, and leaves the neck to enter the thorax by passing under cover of the subclavian vein, and crossing the internal mammary artery from without inwards. As it proceeds downwards on the scalenus anticus, it passes behind the omo-hyoid, the transversalis colli artery, the suprascapular artery, and on the left side the thoracic duct.

The phrenic nerve gives off no branches in the neck, but before it enters the thorax, it is usually joined by a small sympathetic twig.

Communicating Branches.—(1) At the base of the skull, the first loop of the cervical plexus is brought into close connection, by means of connecting twigs, with the *vagus* and *hypoglossal nerves.* These cannot be displayed at present, but will be examined in a subsequent dissection. (2) Each of the four cervical nerves which form the plexus is connected by means of one or more communicating filaments with the superior cervical ganglion of the sympathetic. (3) Communications are effected indirectly in two places by the second, third, and fourth nerves with the spinal accessory, viz., in the substance of the sterno-mastoid by the twig from the second nerve to this muscle, and again on the under surface of the trapezius by the branches which go to this muscle from the third and fourth nerves.

Common Carotid Artery (arteria carotis communis).—The common carotid is the great artery of supply to the head and the neck. Its origin is different on the two sides of the body. On the *right side*, it springs with the subclavian from the innominate artery behind the upper part of the sterno-clavicular articulation; on the *left side*, it arises within the thorax, from the aortic arch. In both cases the common carotid ends opposite the fourth cervical vertebra, or at a level corresponding to the upper border of the thyroid cartilage by dividing into the external and internal carotid branches. The point at which this subdivision takes place is subject to a considerable amount of variation within certain limits, and it has been noticed that in short necked individuals the common carotid artery is relatively longer than in long necked people. The course which the common carotid arteries pursue in the neck, and the relations which they exhibit, are so much alike on the two sides that one description will suffice for both.

The course of the common carotid is slightly oblique, and

may be marked on the surface by drawing a line from the sterno-clavicular articulation to a point midway between the lower jaw and the mastoid process. At the root of the neck the two vessels are close together, the trachea and œsophagus alone intervening, but as they proceed upwards they diverge slightly from each other, and where they end they are separated by the entire width of the thyroid cartilage and the pharynx.

Together with the internal jugular vein, the pneumogastric nerve, and the descendens hypoglossi nerve, the vessel is enveloped by a strongly marked sheath derived from the cervical fascia. This has been removed, but its constitution, and the relation which its contents bear to each other within it, have been already observed (pp. 198, 217).

The common carotid artery is very differently circumstanced in regard to the surface in its lower and upper parts. Opposite the cricoid cartilage it is crossed by the anterior belly of the omo-hyoid, and below this it is placed very deeply, being covered by the integument, platysma, and deep fascia, and by three muscular strata, viz., the sterno-mastoid, the sterno-hyoid, and the sterno-thyroid.

Above the level of the omo-hyoid muscle it lies within the limits of the carotid triangle, and is therefore placed nearer the surface. Here it is merely overlapped by the anterior margin of the sterno-mastoid muscle, and covered by the platysma, fasciæ, and integument. The vessels and nerves in relation to its anterior surface are :—

1. Superior thyroid vein.
2. Middle thyroid vein.
3. Anterior jugular vein.
4. Sterno-mastoid artery.
5. Descendens hypoglossi nerve and the ansa hypoglossi.

The *three veins* cross the common carotid from within outwards, and at different levels, viz., the *superior thyroid* near its bifurcation, the *middle thyroid* below the level of the cricoid cartilage, and the *anterior jugular* at the root of the neck ; whilst, however, the thyroid veins are in im-

mediate relation to the vessel, the anterior jugular vein is separated from it by the sterno-hyoid and sterno-thyroid muscles. The *sterno-mastoid artery*, a branch of the superior thyroid, crosses the vessel obliquely as it lies within the carotid triangle. The *ramus descendens hypoglossi* proceeds downwards and inwards upon the vessel, and within its sheath. The *ansa hypoglossi* is formed upon the anterior aspect of the common carotid artery by the union of the

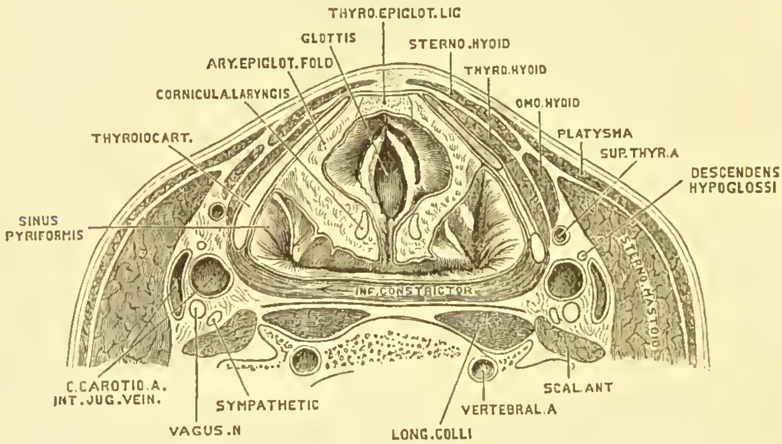

FIG. 219.—Transverse section through the neck, just below the upper border of the thyroid cartilage and the bifurcation of the common carotid artery. The relations of the common carotid at this level to the pharynx, to surrounding nerves, muscles, &c., are well seen.

ramus descendens hypoglossi with the ramus descendens cervicalis.

Behind, the vessel is in apposition with the longus colli and the scalenus anticus muscles. These intervene between it and the transverse processes of the cervical vertebræ. The gangliated cord of the sympathetic, the recurrent laryngeal nerve, and the inferior thyroid artery are also related to it posteriorly. The *sympathetic cord* descends vertically in the substance of the carotid sheath, behind the artery, and is interposed between the vessel and the pre-

vertebral muscles; the *recurrent laryngeal nerve* is carried upwards and inwards behind the lower part of the vessel; the *inferior thyroid artery* crosses behind the carotid sheath about the level of the sixth cervical vertebra.

To the *outer side* of the common carotid artery lie the pneumogastric nerve and the internal jugular vein,[1] whilst *internally*, it is in contact with a succession of structures as it proceeds upwards, viz., (1) the trachea and œsophagus, with the recurrent laryngeal nerve in the groove between them; (2) the lateral lobe of the thyroid body, which overlaps the vessel; (3) the larynx and the pharynx.

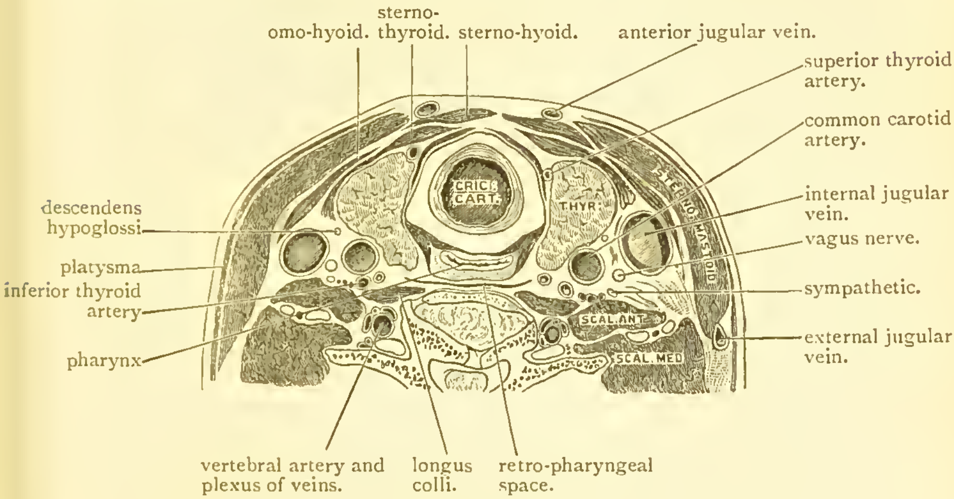

Fig. 220.—Transverse section through the neck at the level of the cricoid cartilage.

As general rule, the common carotid artery gives off no collateral branches, and its calibre is of nearly equal diameter throughout, except close to its bifurcation, where a slight bulging or dilatation may usually be noticed.

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[1] On the left side, at the root of the neck, the internal jugular vein is closely applied to the artery—so close is it, indeed, that it may be said to overlap it. On the right side, however, the vein is separated from the artery by a slight interval, through the middle of which the vagus nerve passes down perpendicularly.

Inter-carotic Body—(Fig. 213, p. 217).—This is a little oval reddish-brown body, placed upon the deep aspect of the common carotid artery at the point where it bifurcates. To expose it, therefore, the vessel must be twisted round in such a manner that its posterior surface comes to look forwards. It is closely connected with the sympathetic filaments which twine around the carotid vessels, and for a time was regarded as belonging to the sympathetic nervous system. Its structure, however, shows it to be an arterial gland similar in its nature to the minute coccygeal body which rests upon the anterior aspect of the tip of the coccyx. Entering it are numerous minute arterial twigs, which take origin from the termination of the common carotid and the commencement of the external carotid. The function of this remarkable little body is quite unknown. Most likely it is a vestigial structure in connection with the second visceral cleft.

The External Carotid Artery (arteria carotis externa) commences at the upper border of the thyroid cartilage, and, taking an upward course, it ends in the substance of the parotid gland, immediately behind the neck of the lower jaw, by dividing into the superficial temporal and the internal maxillary arteries. It is termed *external* not on account of its position in relation to the internal carotid, but on account of its being mainly distributed to parts on the exterior of the skull. Indeed, at its origin its position in relation to the internal carotid is the very reverse of that which its name implies. It lies in front of the internal carotid, and somewhat to its inner side. As it ascends, however, it inclines slightly backwards, so that very shortly it comes to lie directly over the internal carotid.

The external carotid artery may be divided very conveniently into three stages, corresponding to three marked changes in the relations which it presents. The *first stage* is contained within the carotid triangle. It is therefore, comparatively speaking, superficial. Here it is overlapped

by the anterior border of the sterno-mastoid, covered by the platysma, fasciæ, and integument, and crossed by the lingual and common facial veins as they run towards the internal jugular vein. The *second stage* is more deeply placed. It lies under cover of the posterior belly of the digastric and the stylo-hyoid muscle, and is crossed by the hypoglossal nerve. The *third stage* is in relation to the

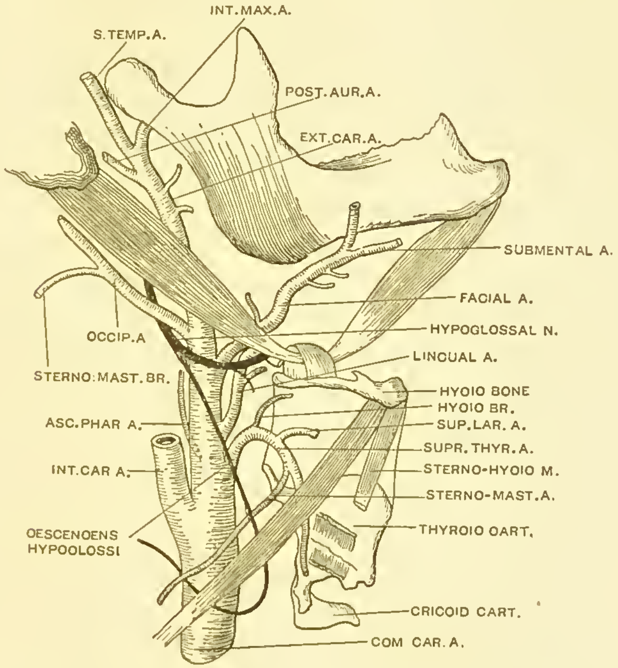

FIG. 221.—Diagram of the external carotid artery and its branches.

parotid gland. Emerging from under cover of the digastric and stylo-hyoid muscles, the artery ascends for a short distance under cover of the lower part of the parotid gland, and finally sinks into its substance. Whilst in the parotid gland, the external carotid artery is crossed near its termination by the facial nerve, whilst the temporo-maxillary vein passes downwards superficial to it.

These relations cannot be seen at present, but they will afterwards be exposed when the face is dissected. It should be noted that while the artery is in the gland it lies much nearer its deep than its superficial surface. Indeed, sections through the parotid region of the frozen head show that in reality only a very small part of the terminal portion of the artery is enclosed within the gland. Below this it merely lies in a groove on the deep surface of the parotid (Fig. 223, p. 267).

At its commencement, the external carotid artery lies in relation to the pharynx. Higher up it rests upon the stylo-pharyngeus muscle, the styloid process and the glosso-pharyngeal nerve—three structures which intervene between it and the internal carotid artery.

Branches of the External Carotid.—As the external carotid ascends, it diminishes rapidly in calibre, owing to the numerous large branches which it gives off.

It is customary to classify these, according to the direction which they take, into the following groups:—

Superior thyroid, Lingual, Facial, Internal maxillary,	Directed forwards and inwards.
Occipital, Posterior auricular,	Directed backwards and outwards.
Ascending pharyngeal, Superficial temporal,	Directed almost vertically upwards.

But these are not the only branches which come off from the external carotid. Small twigs are also given to the *parotid gland*, and to the *masseter* and *internal pterygoid muscles*.

The Superior Thyroid Artery (arteria thyreoidea superior) arises within the carotid triangle, from the fore part of the external carotid close to its origin. From this it takes a curved course downwards and forwards, under cover of the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles, and ends by

breaking up into twigs, which enter the substance of the thyroid body.

The following branches proceed from it :—

1. Hyoid.
2. Superior laryngeal.
3. Sterno-mastoid.
4. Crico-thyroid.
5. Thyroid.

The *hyoid* (ramus hyoideus) is a minute twig, which springs from the superior thyroid before it leaves the carotid triangle, and runs transversely inwards under cover of the thyro-hyoid muscle, and along the lower border of the hyoid bone. It anastomoses with its fellow of the opposite side, and with the hyoid branch of the lingual artery.

The *superior laryngeal artery* (arteria laryngea superior) is a larger vessel. It springs from the superior thyroid as it lies in the carotid triangle, and associating itself with the internal laryngeal nerve, it enters the larynx by piercing the thyro-hyoid membrane.

The *sterno-mastoid artery* (arteria sternocliedomastoidea) is a small vessel which runs downwards and outwards across the carotid sheath, to reach the deep surface of the sterno-mastoid muscle, into which it sinks. It gives, in addition, minute twigs to the depressor muscles of the larynx, and its only claim to special description is the position it occupies in relation to the common carotid artery.

The *crico-thyroid artery* (ramus cricothyreoideus) runs inwards upon the crico-thyroid membrane, and anastomoses with its fellow of the opposite side. It has already been noticed, in the dissection of the middle line of the neck (p. 222).

The *thyroid* or *terminal branches* (rami glandulares) of the superior thyroid artery spring from the main trunk at the apex of the lateral lobe of the thyroid body. Three main branches may be recognised ; of these the largest is distributed on the posterior surface of the lateral lobe ; the smallest ramifies on its outer surface ; whilst the third is carried downwards upon the inner aspect of the lateral lobe, and then along

the upper border of the isthmus towards its fellow of the opposite side. The anastomosis between the thyroid arteries of the two sides is by no means free.

The *superior thyroid vein* emerges from the upper part of the thyroid body. It receives tributaries, which, in a great measure, correspond with the branches of the artery, and crosses the upper part of the common carotid to join the internal jugular vein.

Lingual Artery (arteria lingualis).—Only a small portion of this artery is seen in the present dissection. It springs from the external carotid, a short distance above the superior thyroid. In the first instance, it takes an upward course, but very soon it changes its direction, and bends suddenly downwards to reach the upper border of the hyoid bone. Here it disappears from view by passing forwards under cover of the hyoglossus muscle, and it will subsequently be traced to its ultimate distribution in the dissection of the submaxillary region. Note in the meantime, however, that the part under observation lies in the carotid triangle, that the loop which it forms is crossed by the hypoglossal nerve. One small branch, termed the *hyoid artery*, springs from this part of the vessel.

The *hyoid branch* (ramus hyoideus) arises from the lingual, close to the posterior margin of the hyoglossus muscle, and runs inwards along the upper margin of the hyoid bone to anastomose with the corresponding vessel of the opposite side, and also with the hyoid branch of the superior thyroid.

The Facial Artery (arteria maxillaris externa) can be studied, at the present stage of the dissection, from its origin up to the point where it mounts upon the base of the mandible to reach the face. This is termed the *cervical part* of the facial artery. It springs from the fore part of the external carotid, immediately above the lingual, and then proceeds upwards and forwards. Finally, it enters the region of the face at the anterior border of the masseter muscle by passing over the base of

the mandible. In its course through the neck, it presents stages very similar to those already noticed in connection with the external carotid. Thus it first lies in the carotid triangle, then it disappears under cover of the posterior belly of the digastric, the stylo-hyoid muscle and the hypoglossal nerve; and finally it is enclosed within the substance of the submaxillary gland. With regard to this latter part of the artery, it is necessary that the dissector should note: (1) that the vessel can be disengaged from the submaxillary gland by dissection without lacerating the gland structure; it is placed, as it were, in a deep furrow in the gland substance; (2) that in this part of its course it is almost horizontal, and parallel with the lower margin of the mandible; (3) that on emerging from the gland it turns abruptly upwards to reach the face; and (4) that the facial vein passes backwards and downwards superficial to the submaxillary gland.

Four named branches spring from the facial artery in the cervical part of its course:—

1. The inferior palatine.	1. The submaxillary.
2. The tonsillitic.	2. The submental.

The *inferior palatine artery* (arteria palatina ascendens) is given off for the supply of the soft palate, but it also gives branches to the tonsil and Eustachian tube. It ascends between the stylopharyngeus and styloglossus muscles. The *tonsillitic artery* (ramus tonsillaris) goes to the tonsil, and at present is seen disappearing between the internal pterygoid and styloglossus muscles. Both of these vessels will be traced to their destination in the deep dissection of the neck, and in the dissection of the pharynx.

The *submaxillary branches* are given to the gland during the sojourn of the facial artery in its midst.

The *submental artery* (arteria submentalis) is a branch of some size. It springs from the facial, close to the base of the mandible, and then runs forwards upon the

mylo-hyoid muscle towards the chin. Near the symphysis it changes its direction, and is carried upwards over the base of the lower jaw, to end in branches for the muscles and integument of the chin and lower lip. In the submaxillary region it gives numerous twigs to the surrounding muscles, and anastomoses with the sublingual artery by branches which pierce the mylo-hyoid muscle. In the face it anastomoses with the inferior labial branch of the facial and the mental branch of the inferior dental.

Facial Vein.—The *cervical portion* of the facial vein will be noticed passing backwards and downwards, superficial to the submaxillary gland and facial artery. After picking up tributaries corresponding to the branches of the similar part of the artery, it joins the anterior division of the temporo-maxillary vein. The short trunk thus formed is termed the *common facial vein*, and it pours its blood into the internal jugular at the level of the hyoid bone.

The Internal Maxillary Artery (arteria maxillaris interna) will be displayed in the dissection of the pterygo-maxillary space.

Occipital Artery (arteria occipitalis).—The occipital artery springs from the posterior aspect of the external carotid at the same level as the facial. It takes the lower border of the posterior belly of the digastric muscle as its guide, and runs upwards and backwards to reach the interval between the mastoid process and the transverse process of the atlas. From this onwards it has been studied in the dissection of the scalp and the back of the neck (pp. 111, 141, and 151). The first part of the vessel crosses the internal carotid artery, the vagus nerve, the spinal accessory nerve, and the internal jugular vein. The hypoglossal nerve hooks round it, and it is overlapped by the lower border of the posterior belly of the digastric muscle.

The only branches which spring from this portion of the occipital are :—(1) muscular twigs ; and (2) a meningeal branch.

The *muscular twigs* (rami musculares) are given to the neighbouring muscles, and one of them, larger than the others and very constant, is termed the *sterno-mastoid branch*, because it associates itself with the spinal accessory nerve, and sinks with it into the substance of the sterno-mastoid muscle.

The *meningeal branch* (ramus meningeus) associates itself with the internal jugular vein, and can be followed upwards upon it to the jugular foramen, through which it passes into the cranium.

The Posterior Auricular Artery (arteria auricularis posterior) will be found above the level of the posterior belly of the digastric, and, like the occipital, it takes origin from the hinder aspect of the external carotid artery. In the first part of its course it is placed deeply, and runs upwards and backwards upon the styloid process of the temporal bone to reach the interval between the mastoid process and the back of the auricle. Here it joins the posterior auricular nerve, and its further course has been studied in the dissection of the scalp (p. 110). Before gaining this point it lies under cover of the lower portion of the parotid gland.

This portion of the posterior auricular artery gives off—(1) muscular twigs; (2) a few branches to the parotid gland; and (3) the stylo-mastoid artery.

The *stylo-mastoid artery* (arteria stylomastoidea) is a slender vessel which enters the stylo-mastoid foramen upon the facial nerve. In the interior of the temporal bone it has an extensive distribution. It supplies twigs to the mastoid cells and to the tympanum, and is carried onwards in the aqueduct of Fallopius to anastomose with the petrosal branch of the middle meningeal.

The Ascending Pharyngeal Artery (arteria pharyngea ascendens) is the smallest branch of the external carotid. It takes origin a short distance from the commencement of the parent trunk, and will be recognised by its proceeding vertically upwards between the internal carotid artery and

the pharynx. It will be subsequently traced in the deep dissection of the neck.

The Superficial Temporal Artery (arteria temporalis superficialis) cannot be displayed at present. In the dissection of the face the student will have an opportunity of studying it.

The Thyroid Body may now be examined. It is a highly vascular solid body, which clasps the upper part of the trachea, and extends upwards for some distance upon each side of the larynx. In size it varies greatly in different individuals, and in females and children it is always relatively larger than in adult males. It consists of three well-marked subdivisions, viz., two lateral lobes joined across the middle line by the isthmus. Each *lateral lobe* is somewhat conical in form, its base extending downwards as far as the fifth or the sixth tracheal ring, whilst its apex rests upon the side of the thyroid cartilage. Its *superficial surface* is full and rounded, and is clothed by the pre-tracheal layer of cervical fascia, from which it derives a sheath, and also by the sterno-thyroid, sterno-hyoid, and omo-hyoid muscles. It is further overlapped by the sterno-mastoid muscle (Fig. 220, p. 251). Its *deep surface* is adapted to the parts upon which it lies, viz., to the side of the trachea, the cricoid cartilage, and the thyroid cartilage; whilst its *posterior border* extends backwards so as to touch the œsophagus and pharynx, and overlap the common carotid artery.

The *isthmus* of the thyroid body has already been observed in the dissection of the middle line of the neck. It is a narrow band of varying width which lies in front of the second, third, and fourth rings of the trachea, and unites the bases or lower ends of the two lateral lobes.

A still further lobe is frequently found in connection with the thyroid body. This is the *pyramidal* or the *middle lobe*. When present it assumes the form of an elongated slender process which springs from the isthmus on one or other side of the mesial plane (more usually on the left side), and

extends upwards towards the hyoid bone. To this it may be connected by fibrous tissue, or perhaps by a narrow slip composed of muscular fibres, which receives the name of *levator glandulæ thyroideæ.* In some cases this little muscle has an attachment to the thyroid body independently of the pyramidal process. The thyroid body is firmly connected to the parts upon which it lies, and therefore follows the larynx in all its movements.

The dissector will not fail to be struck with the great vascularity of the thyroid body. Four large arteries, and occasionally a fifth smaller vessel, convey blood to its substance. The two *superior thyroid branches* of the external carotid arteries divide at the apex of each lateral lobe into three branches for its supply ; the two inferior thyroid branches of the subclavian arteries distribute their terminal branches to the basal portion and deep surface of each lateral lobe. The occasional artery is the *thyroidea ima*, a branch of the innominate (more rarely of the common carotid or the aortic arch), which ascends upon the anterior aspect of the trachea to reach the isthmus of the thyroid body. These thyroid arteries anastomose with each other.

The veins which drain the blood away from the thyroid body are still more numerous. They arise in part by tributaries which spring from a venous network on the anterior face of the structure, but chiefly by branches which emerge from its substance. They are *three* in number on each side—viz., the superior thyroid, the middle thyroid, and the inferior thyroid. The *superior and middle thyroid veins* cross the common carotid artery and join the internal jugular ; the *inferior thyroid* descends in front of the trachea. At the root of the neck it usually joins its fellow of the opposite side to form a common stem which opens into the left innominate.

The Trachea and the Œsophagus in the cervical portion of their course may now be studied. Both begin at the level of the cricoid cartilage, in front of the sixth cervical vertebra. From this point they extend downwards in front of the vertebral column to the thoracic cavity.

The *trachea*, or *windpipe*, is a wide tube which is kept constantly patent by the cartilaginous rings embedded in its walls. These rings do not form complete circles ; posteriorly they are deficient, and in consequence the trachea is flattened behind. Above it is continuous with

the larynx, and throughout its whole course it is placed in the mesial plane of the body. The *anterior* relations of the trachea have already been fully discussed in connection with the description of the parts occupying the middle line of the neck (p. 222). *Posteriorly*, it rests upon the gullet. Upon *either side* is the common carotid artery; whilst closely applied to it in its upper part is the lateral lobe of the thyroid body. The recurrent laryngeal nerve ascends on each side in the angle between the trachea and œsophagus.

The *œsophagus* or *gullet* is a narrow tube with thick muscular walls, which extends from the pharynx to the stomach. In the cervical part of its course it lies between the trachea and the prevertebral muscles, and as it descends it inclines slightly to the left, so that it comes more closely into relation with the lateral lobe of the thyroid body and the carotid sheath upon this side than with the same structures on the opposite side.

DISSECTION OF THE FACE.

The deep parts of the neck cannot be displayed satisfactorily until the pterygo-maxillary and submaxillary regions have been opened up. It is necessary, therefore, at this stage to leave the neck and proceed with the dissection of the face.

Surface Anatomy of the Ocular Appendages.—Before the skin is reflected from the face, the external anatomy of the various appendages of the eye should be studied. Under this head we examine :—

1. The eyebrows.
2. The eyelids.
3. The conjunctiva.

The *eyebrows* are two curved tegumentary projections placed over the orbital arch of the frontal bone, so as to

intervene between the forehead above and the ocular regions below. The short stiff hairs which spring from these have an outward inclination. Whilst this is the general arrangement, however, it will be seen that the lower hairs at the same time incline upwards and the upper hairs incline downwards.

The *eyelids* are two semilunar curtains provided for the protection of each eyeball. The upper lid is the longer and much the more moveable of the two. When the eye is open the margins of the two lids are slightly concave and the interval between them is elliptical in outline. This interval is termed the *palpebral fissure.* When the eye is closed and the margins of the lids are in apposition with each other, the palpebral fissure is reduced to a nearly horizontal line. Owing to the greater length and freer mobility of the upper lid, the fissure in this condition is placed below the level of the cornea.

At the extremities of the palpebral fissure the eyelids meet and form the *palpebral commissures* or *canthi*, and at the inner canthus the fissure expands into a small triangular space called the *lacus lachrymalis.* If the dissector now examine the free margins of the lids he will observe that to the outer side of the lacus lachrymalis they are flat, and that in each case the eyelashes project from the anterior border, whilst the *Meibomian follicles* open along the posterior border,—a distinct interval intervening between the cilia and the gland-mouths. The small portion of the margin of each eyelid, on the other hand, which bounds the lacus lachrymalis is more horizontal in direction, somewhat rounded and destitute both of eyelashes and Meibomian follicles. At the very point where the eyelashes in each eyelid cease, and the palpebral margin becomes rounded, a minute eminence with a central perforation will be seen. The eminence is the *papilla lachrymalis*, whilst the perforation, called the *punctum lachrymale*, is the mouth of the lachrymal canal the duct which conveys away the tears. Endeavour

to pass a bristle into each of the orifices. The upper canal at first for a short distance ascends, whilst the lower one descends, and then both run inwards to the lachrymal sac.

The *conjunctiva* is the membrane which lines the deep surface of both the lids, and is reflected from them on to the anterior aspect of the eyeball. At the margins of the lids, it is continuous with the skin, whilst through the puncta lachrymalia and the lachrymal canals it becomes continuous with the lining membrane of the lachrymal sac. The line of reflection of the conjunctiva from the lids on to the eyeball is termed the *fornix*. Owing to the greater depth of the upper lid the conjunctival recess between the upper lid and the eyeball is of greater extent than that in connection with the lower lid. The connection between the conjunctiva on the one hand, and the eyelids and sclerotic coat of the eyeball on the other, is of a loose character. Over the cornea, however, the membrane becomes thinned down to a mere epithelial covering, which is closely adherent.

In connection with the conjunctiva the *plica semilunaris* and the *caruncula lachrymalis* must be examined. The caruncula is the reddish fleshy-looking elevation, which occupies the centre of the lacus lachrymalis at the inner canthus. From its surface a few minute hairs project. The plica semilunaris is of interest because in the human eye it is the rudimentary representative of the membrana nictitans, or third eyelid, of the bird and many other animals. It is a small vertical fold of conjunctiva, which is placed immediately to the outer side of the caruncula and slightly overlaps at this point the eyeball.

Dissection.—The dissection of the face is both difficult and tedious. The ramifications of the nerves are so intricate, and the fibres of the facial muscles are so pale, and so closely surrounded by the soft subcutaneous fat of the region, that great care and patience are required on the part of the student to obtain a proper display of the various structures. In cases where the dissection is undertaken for the first time, it may be well to devote particular attention to the nerves and muscles on the one side, and to the vessels and muscles on the opposite

side. At the same time it must be clearly understood that a good dissector should be able to make a complete dissection upon both sides.

It will facilitate the dissection if the student introduce under the eyelids, cheeks, and lips a small quantity of cotton-wadding or tow soaked in spirit. The margins of the lips and eyelids may then be stitched together. In doing this it is necessary to employ a fine needle. Only one incision is required for the reflection of the skin—viz., a vertical cut carried upwards immediately in front of the ear until it meets the coronal incision which was made in reflecting the integument from the scalp. The skin may then be thrown forwards as far as the middle line of the face and removed entirely.

In raising the skin the dissector must proceed with caution. Carefully preserve the fibres of the platysma as they pass upwards upon the lower jaw to blend with the fascia, to find insertion into the bone and mix with the fibres of certain of the facial muscles (p. 190). The little *risorius muscle* as it passes forwards from the masseteric region to the angle of the mouth is apt to be injured, and must therefore be remembered. In the case of the eyelids the skin is thin and is separated from the subjacent muscular fibres by a small amount of areolar tissue devoid of fat. Some care therefore is required on the part of the dissector to remove it successfully. Over the ala of the nose and the chin, the integument is difficult to raise on account of its density and also from its close connection with subjacent structures.

When the skin is completely reflected, and the attachments of the platysma satisfactorily demonstrated, the latter may be turned up so as to expose the facial artery passing upwards upon the jaw.

The Facial Branch of the *Great Auricular Nerve* must next be traced. Several small filaments from this will be seen to penetrate the parotid gland, for the purpose of joining the facial nerve. Others proceed forwards, and supply the skin over the parotid, masseteric, and buccal regions.

The parotid gland should now be defined. In doing this the greatest care must be taken not to injure the branches of the facial nerve and the transverse facial artery, as they emerge from its substance, along its upper and anterior borders. The duct also, which appears at its anterior border, must be followed forwards upon the masseter muscle. When the superficial relations of the parotid have been examined, the gland-substance must be removed piece-meal, so as to bring into view the various structures with which its deep surface is in contact, and at the same time expose the blood vessels and nerves which traverse it. This can best be effected by tracing into it the branches of the facial nerve, and the trunk of the transverse facial artery. Care must be taken not to injure

the auriculo-temporal nerve, which ascends under cover of the upper part of its posterior border. The communicating twigs from the auriculo-temporal and great auricular nerves to the facial nerve, must be preserved. By this dissection the termination of the external carotid artery and the temporo-maxillary vein will be displayed.

The Parotid Gland is the largest of the salivary glands. It is lodged in the niche between the lower jaw and the ear, and being adapted to this recess, it presents a very irregular figure. *Above*, it is limited by the zygoma. *Below*,

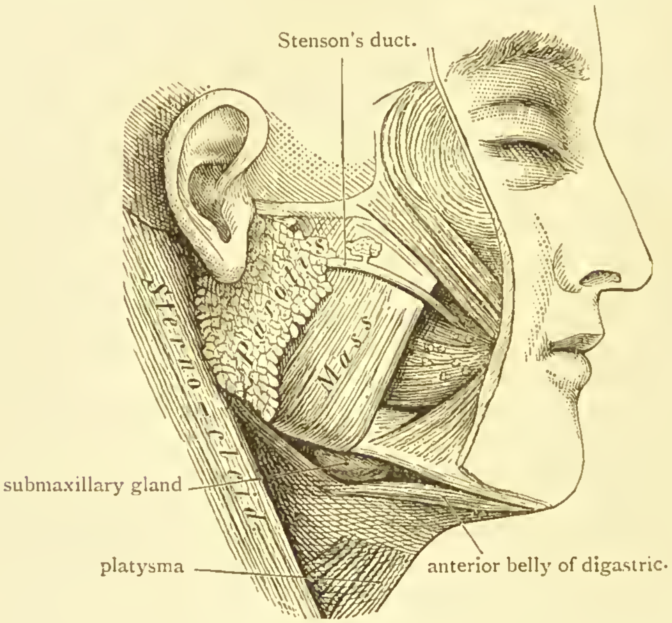

FIG. 222. (From GEGENBAUR.)

its lower border is in apposition with the posterior belly of the digastric muscle, and is separated from the submaxillary gland by that partition of the deep cervical fascia which the student has already studied under the name of the stylo-maxillary ligament. *Behind* it abuts against the auditory meatus, the mastoid process, and the sterno-mastoid muscle. In *front* it will be seen to overlap the posterior border of the masseter, and extend forwards upon it for some distance

(Fig. 223). It is from the thin anterior margin towards its upper part that the duct of the gland emerges, and frequently a small detached lobule of gland substance will be observed lying upon the masseter in relation to the upper aspect of the duct (Fig. 222). This is termed the *socia parotidis.*

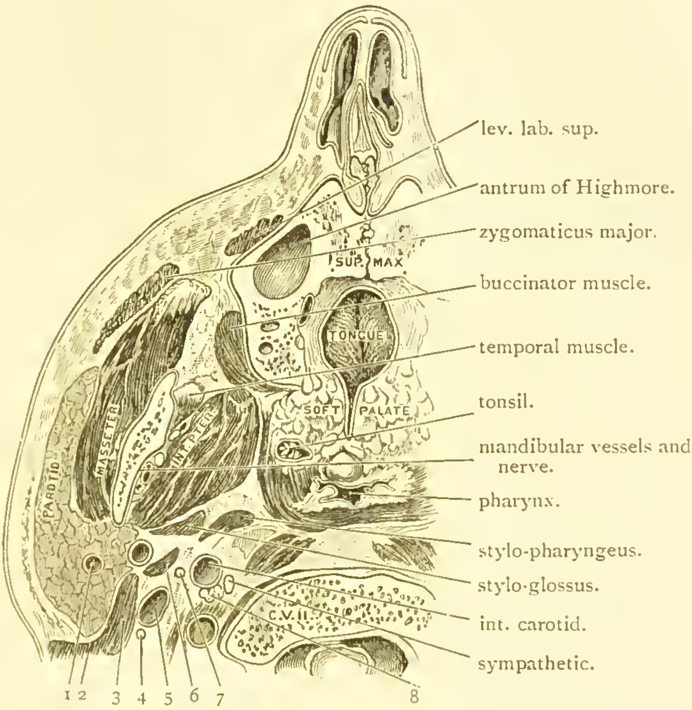

FIG. 223.—Transverse section through the head at the level of the hard palate. It shows very well the relations of the parotid gland, &c.

1. Temporo-maxillary vein.
2. Sterno-mastoid muscle.
3. Digastric (posterior belly).
4. Spinal accessory nerve.
5. Internal jugular vein.
6. Stylo-hyoid.
7. Glosso-pharyngeal nerve.
8. Vagus and hypoglossal nerves.

The *superficial* or *external surface* of the parotid is slightly convex, and is covered by the dense parotid fascia which the dissector has already observed to be a prolongation upwards into the face of a portion of the deep cervical fascia (p. 196).

In relation to this surface, and under cover of the fascia, there are usually one or two small lymphatic glands.

The *deep surface* of the gland is in relation to many important structures, and is moulded upon the various parts with which it is in contact.

It rests upon the styloid process and the muscles which proceed from it, and is closely related to the internal jugular vein and the vagus, spinal accessory and hypoglossal nerves. A portion of the gland substance (sometimes called the *glenoid lobe*) occupies the posterior or tympanic part of the glenoid fossa, whilst in front, another portion extends forwards for a short distance under cover of the ramus of the mandible and the internal pterygoid muscle.

The *fascial connections* of the parotid gland deserve some attention. The recess in which it lies is lined by a well-marked fascia, which separates it from subjacent structures, and we have noted the parotid fascia upon its superficial aspect. The entire gland is enveloped, therefore, in a strong envelope, which sends numerous strong septa into its substance, and accentuates its lobular appearance. The parotid fascia presents very important connections. Above, it is attached to the zygoma; behind, it is attached to the meatus auditorius, and below that, it splits to enclose the sterno-mastoid; in front, it is continuous with the fascia over the masseter, whilst below, it is continuous with the deep cervical fascia.

Parotid Duct.—This is also called *Stenson's duct.* It issues from the anterior border of the gland, and proceeds forwards upon the masseter muscle about half-an-inch below the zygoma. In relation to it above will be seen the socia parotidis and the transverse facial artery, whilst accompanying it below, are some branches of the facial nerve. At the anterior border of the masseter, it dips inwards, and, piercing the buccinator, runs forwards for a short distance between this muscle and the mucous membrane. Finally, at a point corresponding with the second molar tooth of the upper jaw,

it opens into the mouth by a minute orifice placed on the summit of a small papilla. In length, the duct measures about two inches, and its course may be marked out on the surface of the cheek by drawing a line from the lower part of the external auditory meatus of the auricle to a point midway between the nostrils and the margin of the red part of the lip. The dissector should now open the duct, and pass a fine probe through it into the mouth. The calibre of the tube will then be observed to be greatly reduced at its opening upon the inner aspect of the cheek. Evert the cheek, and examine this orifice.

Vessels and Nerves which traverse the Parotid.—By the removal of the gland, the vessels and nerves which traverse the gland are brought into view. These are :—

1. External carotid artery, dividing into . . { Superficial temporal. Internal maxillary.
2. Transverse facial artery.
3. Temporo-maxillary vein.
4. Facial nerve, or the seventh cranial nerve.
5. Communicating twigs from the great auricular and auriculo-temporal nerves to the facial nerve.

The *external carotid* (arteria carotis externa), as it ascends in the substance of the gland, lies nearer its deep than its superficial surface. In fact, in the lower part of its parotid stage the artery is not placed within the gland, but merely in a groove on its deep surface, and slightly under shelter of the posterior border of the ascending ramus of the lower jaw. Note that the facial nerve crosses superficial to it, and that opposite the neck of the lower jaw it divides into the superficial temporal and the internal maxillary arteries.

The *temporo-maxillary vein* is formed by the union of the superficial temporal and internal maxillary veins behind the neck of the lower jaw. It descends in the substance of the parotid superficial to the external carotid artery. At the lower border of the gland it divides into an anterior and

posterior trunk. The former joins the facial vein, whilst the latter unites with the posterior auricular vein to form the *external jugular.*

The *internal maxillary artery* at once passes forwards under cover of the neck of the jaw and disappears from view. The *superficial temporal artery* may now be fully followed out.

The Superficial Temporal Artery (arteria temporalis superficialis) appears to be the direct continuation upwards of the external carotid artery. At first in the substance of the parotid, it soon emerges from this, and crossing the root of the zygoma, ascends upon the temporal fascia for a variable distance, and then divides into its two terminal branches, the *anterior* (ramus frontalis) and *posterior superficial temporal* (ramus parietalis) *arteries.* These are described in p. 110. The superficial temporal artery is closely accompanied by the auriculo-temporal nerve, and the superficial temporal vein.

In addition to its terminal branches it gives off—

1. Parotid twigs.
2. Anterior auricular branches.
3. The transverse facial.
4. The middle temporal.
5. The orbital.

The *anterior auricular branches* (rami auriculares anteriores) supply the anterior aspect of the external auricle and anastomose with the posterior auricular artery.

The *transverse facial* (arteria transversa faciei) is given off in the substance of the parotid. It runs transversely forwards, and, emerging from under cover of the anterior border of the gland, proceeds onwards across the masseter to end in twigs which anastomose with branches of the facial, buccal and infra-orbital arteries. Whilst it lies on the masseter muscle it is in relation to the upper border of the parotid duct.

The *middle temporal* (arteria temporalis media) arises immediately above the zygoma, and it pierces the temporal fascia to reach the temporal muscle, and communicate

with the deep temporal branches of the internal maxillary artery.

The *orbital artery* (arteria zygomatico-orbitalis) is an inconstant branch which runs forwards above the zygoma to supply the outer part of the orbicularis palpebrarum, and the skin in this neighbourhood.

Muscles of the Face.—The muscles of the face are arranged in groups around the different facial apertures. There is thus a *palpebral* and *superciliary group* in relation to each orbital opening; an *oral group* around the mouth; and a *nasal group* in connection with the nose. Each of these groups may be examined in turn. It is convenient to begin with the palpebral and superciliary muscles. These are three in number:—

1. Orbicularis palpebrarum.
2. Tensor tarsi (Horner's muscle).
3. Corrugator supercilii.

The upper eyelid has a special elevator, termed the *levator palpebræ superioris*, but this muscle is contained within the orbital cavity, and does not come under the notice of the dissector at the present stage. The examination of the *tensor tarsi* must also be deferred until the eyelids are dissected.

Internal Tarsal Ligament.—If the eyelids be drawn outwards, a prominent cord-like ligament becomes apparent on the inner side of the inner canthus. This extends outwards from the nasal process of the superior maxillary bone to reach the eyelids, and is termed the *internal tarsal ligament.* It will be afterwards more fully examined, but it is necessary to notice it at present, seeing that it is closely connected with the origin of the orbicularis palpebrarum.

The Orbicularis Palpebrarum (orbicularis oculi) is the sphincter muscle of the palpebral fissure. It is a thin sheet of muscular fibres, which occupies a very considerable area of the face. It is customary to regard it as being composed of two parts, a palpebral and an orbital.

The *palpebral portion* is the part which lies upon the eyelids. It is thin and pale, and its fibres arise from the margins of the internal tarsal ligament. From these they sweep outwards upon the two lids, describing a series of gentle curves, and at the outer canthus, they obtain attachment to the external tarsal ligament. They form a continuous layer of uniform thickness in both eyelids, except at their free margins. Here, close to the bases of the eyelashes, there is a more pronounced fasciculus, which is termed the *ciliary muscle.*

The *orbital portion* is placed upon the margin of the orbital opening ; but it is not confined to this. It extends for some distance beyond it, upwards on the forehead, downwards on the cheek, and outwards so as to encroach upon the temporal region. The fasciculi which compose this part of the muscle are of a darker and coarser type. They all arise internally and sweep outwards around the orbital margin in the form of a series of concentric loops. The origin is a triple one—viz., (1) from the inner part of the internal tarsal ligament, (2) from the internal angular process of the frontal bone, and (3) from the ascending process of the superior maxillary bone.

Above and to the inner side, the fasciculi of the orbicularis muscle are closely connected, and to a certain extent interlaced with the fasciculi of the frontal part of the occipito-frontalis, the corrugator supercilii and the pyramidalis nasi, whilst from its lower margin a few delicate fleshy bands are carried downwards through the soft fat to gain insertion into the skin of the cheek.

Corrugator Supercilii.—This is a minute but very distinct band of dark coloured muscular fibres which can be exposed by raising the upper and inner part of the orbicularis with the frontalis muscle which is connected with it, from the superciliary ridge. The corrugator supercilii will then be seen arising from the inner extremity of this ridge. Its fibres pass upwards and outwards, and the greater propor-

tion of them pass through the fasciculi of the orbicularis and frontal belly of the occipito-frontalis to gain a direct insertion into the skin of the eyebrow; one of its muscular bundles, however, joins the orbicularis, whilst a few others blend with the frontalis.

The Oral Group of Muscles.—The muscles of the lips and mouth which are included in this group are the following:—

1. Orbicularis oris.	5. Levator labii superioris.
2. Zygomaticus, { major. minor.	6. Levator anguli oris.
	7. Depressor anguli oris.
3. Risorius.	8. Depressor labii inferioris.
4. Levator Labii superioris alæque nasi.	9. Levator menti.
	10. Buccinator.

The orbicularis oris is a sphincter muscle which surrounds the oral aperture. The other muscles of this group, with the exception of the levator menti, converge towards it. From the nasal process of the superior maxilla, and from the lower margin of the orbital opening, the labial slip of the levator labii superioris alæque nasi, and the levator labii superioris descend into the upper lip. Converging upon the angle of the mouth, the dissector will have little difficulty in recognising the zygomaticus major, the risorius, and the depressor anguli oris; whilst placed upon a deeper plane and extending towards the same point are the levator anguli oris and the buccinator. Entering the lower lip from below is the depresssor labii inferioris. The play of the lips is produced by the action of these muscles antagonised to a certain extent by the orbicularis. The levator menti has little connection with the lips. It only acts indirectly on the lower lip, as will be seen when its attachments are studied.

Dissection.—It is in dissecting these muscles that the chief difficulty will be encountered in preserving the various nerves of the face. Several large branches of the facial nerve will be found passing forwards under cover of the zygomatic muscles to reach the under surface of the levator labii superioris, where they form a complicated plexus with the infra-

orbital nerve. Other branches proceed forwards upon the buccinator muscle, and enter into communication in front of the masseter with the long buccal nerve. The supra-mandibular division of the facial nerve will also be noticed on the surface of the lower jaw. Its branches disappear under cover of the depressor anguli oris. All these nerves must be carefully followed out as the muscles are being exposed and cleaned.

Zygomaticus Major, Risorius, and Depressor Anguli Oris.—These three muscles may be grouped together, seeing that they lie in the same plane and run towards the angle of the mouth. The platysma also occupies the same plane,

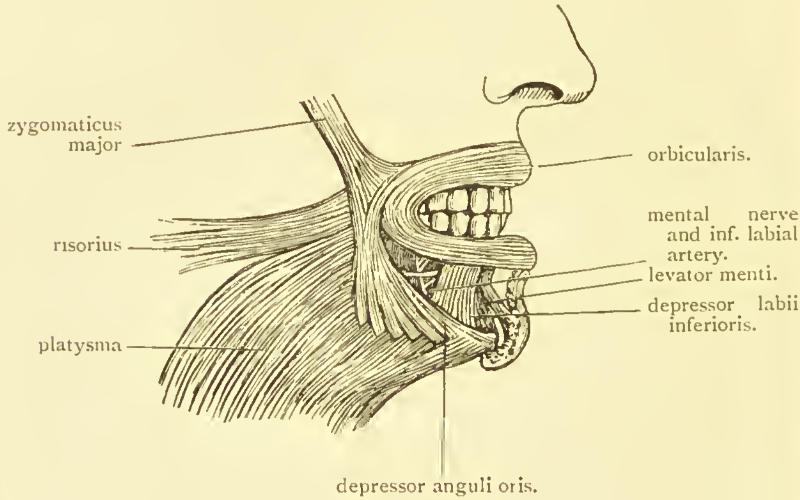

FIG. 224.

and many of its fibres blend with the depressor anguli oris, whilst others are carried forwards into the risorius.

The *Zygomaticus Major* is a long fleshy band which springs from the malar bone immediately in front of the zygomatic suture. From this it proceeds downwards and forwards, and at the angle of the mouth some of its fibres are inserted into the skin, whilst others blend with the orbicularis oris and with the depressor anguli oris.

The *Risorius* is sometimes regarded as a continuation forwards on the face of the posterior fibres of the platysma ;

more frequently it takes independent origin from the fascia covering the masseter, although some of its fibres come directly from the platysma. It is composed of a few slender fasciculi which pass transversely forwards in the fatty tissue of the cheek to the angle of the mouth, where they are inserted into the skin.

The *Depressor Anguli Oris* is a flat triangular muscle which presents a broad origin from the external oblique line of the lower jaw. From this it proceeds upwards to the angle of the mouth. Here its fibres, which are collected in the form of a narrow bundle, are partly inserted into the skin, and partly prolonged into the *upper lip* in the orbicularis oris.

The *mental branch* of the mandibular nerve and its accompanying artery appear on the face under cover of this muscle.

Levator Labii Superioris Alæque Nasi.—This is a thin fleshy band which lies along the side of the nose. It is narrow above where it arises from the nasal process of the superior maxillary bone, but it expands somewhat as it proceeds downwards, and finally it divides into two slips—a nasal and a labial. The *inner* and *smaller nasal slip* is inserted into the wing of the nose, whilst the *labial slip* is prolonged into the upper lip, where some of its fibres blend with the orbicularis oris, and others obtain a direct attachment to the skin.

The Levator Labii Superioris arises from the lower margin of the orbital opening, immediately above the infra-orbital foramen. It takes the form of a flat band which proceeds downwards and slightly inwards, to end in the skin of the upper lip. Under cover of this muscle the large *infra-orbital nerve* emerges on the face, and joins with branches of the facial nerve in the infra-orbital plexus.

The Zygomaticus Minor may be looked upon as a part of the preceding muscle. It is also closely connected with the orbicularis palpebrarum, from which some of its

fasciculi are often derived, and it lies on the same plane as those slender slips which the orbicularis oris sends downwards from its lower margin to the skin of the cheek.

It is a slender fleshy bundle which arises from the anterior and lower part of the zygomatic arch in front of the zygomaticus major, and passes downwards and forwards to join the outer margin of the levator labii superioris.

Levator Anguli Oris (musculus caninus).—The origin of this muscle is hidden by the levator labii superioris. It springs from the upper part of the canine fossa, immediately below the infra-orbital foramen, and proceeds downwards and outwards to the angle of the mouth. Here some of its fasciculi mingle with those of the orbicularis and enter the *lower lip*, whilst others gain a direct insertion into the skin.

It should be noticed that the bundle of fibres which is given by the depressor anguli oris to the upper lip, and the bundle which is contributed by the levator anguli oris to the lower lip, decussate with each other at the angle of the mouth (Fig. 226).

The Depressor Labii Inferioris (quadratus labii inferioris) is a quadrate muscle partially hidden by the depressor anguli oris which overlaps it (Fig. 224). It springs from the lower jaw by a linear origin which extends from the symphysis to a point a short distance beyond the mental foramen, and passing upwards, with an inclination inwards, it joins the corresponding muscle of the opposite side, and is inserted into the skin of the lower lip.

Dissection.—The buccinator muscle must be cleaned with care, because branches from the facial nerve and the long buccal nerve form a plexus upon its surface, and great numbers of nerves enter it, both for the purpose of supplying it, and also for the purpose of reaching the mucous membrane of the mouth which lines its deep surface.

The Buccinator Muscle occupies the interval between the upper and lower jaws. *Above* and *below* its fibres take origin from the outer surface of the alveolar margins of both of

these bones as far forwards as the first molar tooth. *Behind*, its posterior border is attached to the pterygo-maxillary ligament, which acts as the bond of union between it and the superior constrictor muscle of the pharynx. This attachment cannot be studied at present, but will be afterwards examined in the dissection of the pharyngeal wall. Anteriorly, it abuts against the angle of the mouth, and its fibres blend with the orbicularis oris, a large part of which it forms. But the manner in which the fibres of this muscle enter the orbicularis must be examined. The upper and lower fibres pass directly into the corresponding lip; the middle fibres, on the other hand, decussate at the angle of

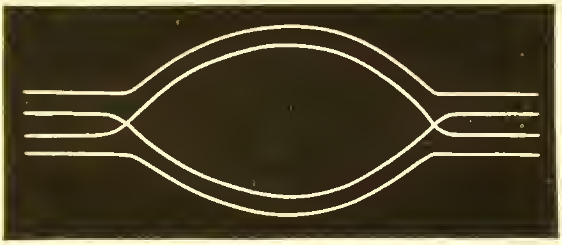

FIG. 225.

the mouth, so that the lower fibres of this series enter the upper lip, whilst the higher fasciculi reach the lower lip.

Orbicularis Oris.—The orbicularis oris is composed of fleshy fasciculi which sweep round the oral aperture in the interval between the skin and mucous membrane, and form a considerable part of the substance of the two lips. Its upper margin extends upwards as high as the nose, whilst its lower margin corresponds to the groove on the face which intervenes between the chin and the lower lip.

The fibres which compose the orbicularis oris are derived from many different sources. The chief bulk of the muscle is formed by the continuation into the lips of fibres which belong to the buccinator, the levator anguli oris, and the depressor anguli oris of each side. The fasciculi of the

buccinator muscle arrange themselves at the angle of the mouth, in the manner already described, into two bundles, and these are prolonged onwards into the two lips so as to encircle the oral aperture, and become continuous with the corresponding fasciculi of the opposite side. These fibres form the marginal part of the orbicularis, and also the deeper peripheral part. The labial portions of the levator anguli

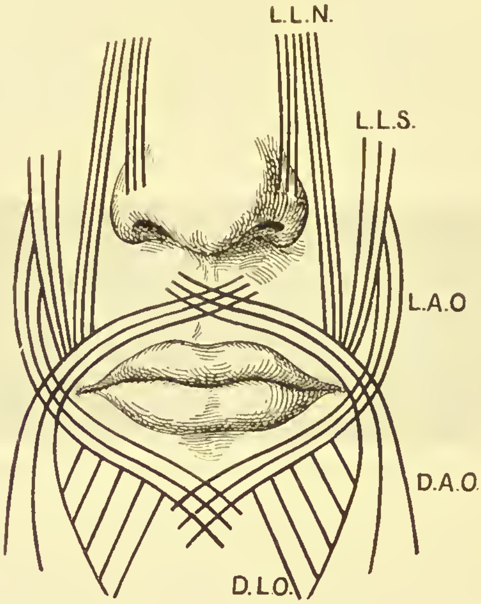

FIG. 226.—Diagram of the orbicularis oris muscle. The fibres which enter it from the buccinator are not represented.

L.L.N. Levator labii superioris alæque nasi.
L.L.S. Levator labii superioris.
L.A.O. Levator anguli oris.
D.A.O. Depressor anguli oris.
D.L.O. Depressor labii inferioris.

oris and the depressor anguli oris are arranged quite differently. The labial slip from the levator anguli oris passes into the lower lip, and the corresponding slip from the depressor anguli oris is continued into the upper lip. In neither case do the fibres reach the opposite angle of the mouth; they are inserted into the skin at the middle of each

lip. The fibres which come from these sources form the superficial peripheral part of the orbicularis.

In addition to the fibres derived from these three muscles, the orbicularis oris receives certain slips which present special attachments. Two are provided for each side of the upper lip, viz., (1) the naso-labial band (*m. naso-labialis*), and (2) the superior incisive band (*m. incisivus superior*); and one, the inferior incisive band (*m. incisivus inferior*), is given to each side of the lower lip. The *naso-labial band* is a rounded bundle which arises from the lower border of the nasal septum, and turns outwards into the orbicularis oris. The *superior incisive bundle* takes origin from the incisor fossa of the superior maxilla, and turns outwards in the orbicularis; whilst the *inferior incisive bundle* arises from the corresponding fossa of the mandible, and presents similar connections in the lower lip.

The incisive slips can be easily exposed by everting the lips, and removing the mucous membrane from the neighbourhood of these fossæ. By this dissection two other small muscles will be displayed: (1) the depressor alæ nasi to the inner side of the superior incisive slip; and (2) the levator menti to the inner side of the inferior incisive slip. The concentric arrangement of the fibres of the orbicularis oris is well seen when the mucous membrane is removed from the deep surface of the lips. Numerous labial glands which lie between the muscle and the mucous membrane are displayed by the same proceeding.

Levator Menti.—To expose this small muscle the lower lip must be everted, and the mucous membrane removed at the side of the frænum of the lower lip. It is a short, well-marked fleshy band, which springs from the incisor fossa of the lower jaw, and proceeds downwards and slightly forward, to be inserted into the skin of the chin between the two depressor muscles of the lower lip (Fig. 224).

Nasal Group of Muscles.—Under this head are comprised:—

1. Compressor naris.
2. Levator labii superioris alæque nasi (already examined).
3. Pyramidalis nasi.
4. Depressor alæ nasi.
5. Dilatator naris posterior.
6. Dilatator naris anterior.

The Compressor Naris is a flat triangular muscle which springs by a pointed fleshy origin from the superior maxillary bone close to the margin of the anterior nasal aperture and under cover of the levator labii superioris alæque nasi. From this it extends inwards and upwards, and expands into an aponeurosis, which covers the cartilaginous part of the nose, and in the mesial plane becomes continuous with the corresponding aponeurosis of the opposite side.

The Pyramidalis Nasi is a narrow slip of muscular fibres which springs from the aponeurosis of the compressor naris, and passes upwards upon the nasal bone. Some of the fibres gain a direct insertion into the skin over the lower part of the forehead; others are continuous with the fasciculi of the frontalis muscle.

The Depressor Alæ Nasi is a minute muscle, the origin of which has already been displayed by the removal of the mucous membrane at the side of the frænum of the upper lip. It springs from the incisor fossa of the superior maxilla above and to the inner side of the superior incisive slip of the orbicularis oris muscle. Its outer margin is usually more or less blended with the compressor naris, and its fibres arch upwards and forwards to become attached to the lower and back part of both the ala and the septum of the nose.

The Dilatator Muscles can rarely be satisfactorily displayed. The fibres which compose them are pale and feeble, and they are embedded in the dense tissue at the lower and outer part of the nose immediately above the aperture. An *anterior slip* (levator proprius alæ nasi anterior) is placed on the lower part of the side of the nose towards the fore part of the nostril, and a *posterior slip* (levator proprius alæ nasi posterior) at a short distance behind this.

Nerves of the Face.—The nerves in this region may be divided into two sets according as they supply the skin or the muscles of the face. The motor nerve is the *nervus*

facialis. The sensory nerves come from various sources, and they reach the face either directly or indirectly through the medium of filaments which join branches of the facial nerve.

The following table shows the derivation of these nerves :—

NERVES OF THE FACE.

I. Motor.

Facial nerve.

II. Sensory.

(*a.*) Appearing directly on the face,

1. Facial branches of the great auricular nerve.
2. Branches of the trigeminal nerve (5th cranial), viz. :—

From the ophthalmic division.	Supra-orbital. Supra-trochlear. Infra-trochlear. Palpebral branch of the lachrymal. Nasal.
From the superior maxillary division.	Infra-orbital. Subcutaneus malæ. Temporal branch of the orbital.
From the inferior maxillary division.	Auriculo-temporal. Long buccal. Mental.

(*b.*) Reaching the face indirectly.

1. Communicating branches from the great auricular nerve to the facial nerve.
2. Communicating branches from the auriculo-temporal nerve to the facial nerve.

Whilst, therefore, the motor filaments come from one source alone, the sensory nerves are derived partly from the cervical plexus through the great auricular nerve, but chiefly from the trigeminal nerve, each division of which furnishes several branches to the face.

Dissection.—The facial nerve is already, in a great measure, displayed. Its exit from the stylo-mastoid foramen can be rendered more evident by chipping off the free projecting part of the mastoid process. In doing this first use the saw, and then complete the severance with the

chisel. Care must be taken not to injure the posterior auricular branch of the facial nerve. By this proceeding a good view can be obtained of the origin of the posterior belly of the digastric, of the stylo-mastoid branch of the posterior auricular artery, entering the foramen of the same name upon the facial nerve, and also of the occipital artery in the deepest part of its course.

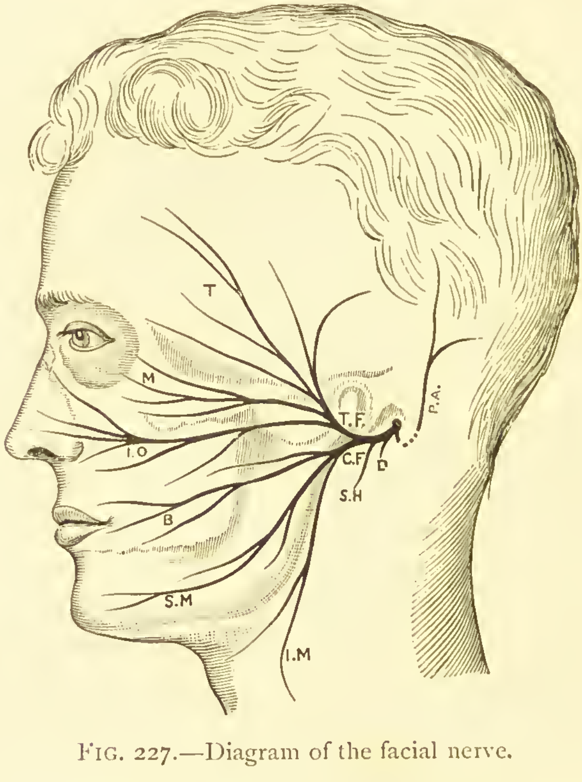

FIG. 227.—Diagram of the facial nerve.

T.F. Temporo-facial division.
C.F. Cervico-facial division.
P.A. Posterior auricular.
D. Branch to the digastric muscle.
S.H. Branch to stylo-hyoid muscle.
T. Temporal branches.
M. Malar branch.
I.O. Infra-orbital branches.
B. Buccal branch.
S.M. Supra-mandibular branch.
I.M. Infra-mandibular branch.

Facial Nerve.—The trunk of the facial nerve emerges from the stylo-mastoid foramen and proceeds forwards in the substance of the parotid gland. Near the posterior margin of the ascending ramus of the lower jaw, it ends by

dividing into two branches, termed respectively the *temporo-facial* and the *cervico-facial divisions.* From this part of the nerve three branches arise, viz. :—the posterior auricular nerve, the nerve to the posterior belly of the digastric muscle, and the nerve to the stylo-hyoid muscle.

The *posterior auricular* nerve has already been followed out in its distribution to the retrahens auriculam, attollens auriculam, and posterior belly of the occipito-frontalis (p. 109). Its origin is now exposed, and it will be seen to arise from the facial trunk immediately after this issues from the stylo-mastoid foramen.

At this stage it may be possible to make out a communication between the auricular branch of the pneumogastric (Arnold's nerve) and the posterior auricular branch of the facial. Arnold's nerve emerges from the interval between the mastoid process and the auditory meatus, and after sending a branch to join the posterior auricular nerve, it ends in filaments for the integument on the posterior aspect of the ear.

The *nerve to the posterior belly of the digastric* is a stout, short branch which inclines downwards and forwards and soon divides into several filaments which enter the upper surface of this muscle. One of these twigs usually passes through the muscle to effect a communication with the glosso-pharyngeal.

The *nerve to the stylo-hyoid* is a longer and more slender filament, which generally arises in common with the preceding, and sinks into the posterior aspect of this muscle.

The Temporo-facial Division of the facial nerve is prolonged forwards through the parotid gland, and at once divides into numerous branches which radiate widely from each other, and stretch over an area extending from the ear behind to the margin of the upper lip below. Whilst within the substance of the parotid gland the temporo-facial nerve crosses the external carotid artery near its termination, and also the temporo-maxillary vein. It receives two, or it may be three, stout branches of communication from the auriculo-temporal nerve, and forms a plexiform arrangement with the

branches of the cervico-facial division in the midst of the parotid gland. This receives the name of the *pes anserinus* or *plexus parotideus.*

The branches into which this portion of the facial trunk divides are classified according to the direction which they take into—

1. Temporal.
2. Malar.
3. Infra-orbital.

The *temporal branches*, three or four in number, emerge from the upper border of the parotid, and are carried upwards over the zygomatic arch to the temporal region. Here they supply the attrahens auriculam, the frontal belly of the occipito-frontalis, the orbicularis palpebrarum, and the corrugator supercilii. They communicate with several branches of the trigeminal or fifth cranial nerve, more especially with the auriculo-temporal, the temporal branch of the orbital, and the supra-orbital.

The *malar branches* run forwards upon the malar bone, and end in filaments, which enter the outer and lower part of the orbicularis palpebrarum muscle. Some of the twigs may be traced to the upper and lower eyelids. On the malar bone they communicate with the malar branch of the orbital nerve, and in the eyelids they are connected with the various branches of the trigeminal nerve which are distributed to these structures.

The *infra-orbital branches* are larger than either of the preceding, and they run horizontally forwards along the lower border of the malar bone, and under cover of the zygomaticus major to the infra-orbital region. Here they supply twigs to the muscles in this neighbourhood as well as to the muscles of the nose. They likewise communicate with the infra-orbital, nasal, and infra-trochlear nerves. With the infra-orbital nerve they form a complicated plexus (the *infra-orbital plexus*), under cover of the levator labii superioris.

The Cervico-facial Division of the facial trunk is smaller than the temporo-facial division. It proceeds forwards, with a slight inclination downwards, and breaks up in the substance of the parotid into three main branches, which are termed from the course which they take—

1. Buccal.
2. Supra-mandibular.
3. Infra-mandibular.

In the parotid gland the cervico-facial division crosses the external carotid artery and receives several communicating twigs from the great auricular nerve.

The *buccal branch* runs forwards upon the buccinator muscle to the angle of the mouth, where it ends in filaments for the orbicularis oris. It supplies the buccinator muscle, and forms, with the *long buccal branch* of the inferior maxillary division of the fifth nerve, a plexus around the facial vein.

The *supra-mandibular branch* proceeds forwards upon the lower jaw to reach the muscles in connection with the lower lip. Under cover of the depressor anguli oris it communicates with the mental branch of the inferior dental nerve.

The *infra-mandibular branch* has already been examined in the dissection of the neck (p. 194).

Sensory Branches to the Face from the Trigeminal Nerve.—The branches which come from the *ophthalmic division of the trigeminal nerve* may first be studied. Of these *two* go to the skin of the forehead and scalp—viz., the supra-orbital and the supra-trochlear; *two*, to the eyelids—viz., the palpebral branch of the lachrymal and the infra-trochlear; and *one*, the nasal, to the skin of the nose.

The *supra-orbital* and the *supra-trochlear* have already been dissected in the scalp (p. 106). They should now be followed downwards to the point where they turn round the orbital arch of the frontal bone. This can be done by cutting through the frontal belly of the occipito-frontalis and the orbicularis palpebrarum under cover of which they

pass upwards. The supra-orbital quits the orbit by the supra-orbital notch or foramen, and the supra-trochlear at a point internal to this. Both nerves give twigs downwards to the skin and conjunctiva of the upper eyelid.

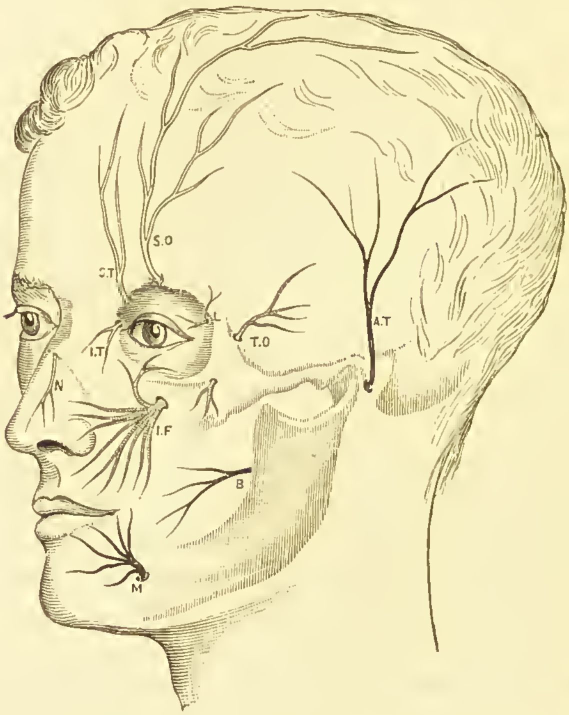

FIG. 228.—Diagram of the sensory branches of the trigeminal nerve to the face. The branches from each of the three divisions of the trigeminal nerve may be recognised from the different shading which has been employed to distinguish them.

A.T. Auriculo-temporal.
B. Buccal.
M. Mental.
T.O. Temporal branch of the orbital.
I.F. Infra-orbital.
S.O. Supra-orbital.
S.T. Supra-trochlear.
I.T. Infra-trochlear.
L. Palpebral branch of lachrymal.
N. Nasal.

The *palpebral* or terminal branch of the *lachrymal* appears in the upper eyelid above the outer canthus where it pierces

the superior palpebral ligament, and gives filaments to the skin and conjunctiva.

The *infra-trochlear nerve* will be found above the internal tarsal ligament and the inner canthus. The twigs into which it divides communicate with the facial and supply the lachrymal sac, the conjunctiva and the skin of the eyelids, and the root of the nose.

The *nasal nerve* reaches the face on the side of the movable part of the nose. To expose it, divide the compressor naris, and it will be found appearing between the lower margin of the nasal bone and the upper lateral cartilage. It gives branches to the integument of the nose and communicates with the facial nerve. It can be traced downwards under cover of the compressor muscle to the tip of the nose.

The branches of the *superior maxillary division of the trigeminal nerve* which appear on the face are three in number, viz., the temporal branch of the orbital nerve, which has been already studied (p. 108); the malar branch of the orbital nerve; and the infra-orbital.

The *malar nerve* (ramus subcutaneus malæ) is an exceedingly minute twig which emerges on the face through a minute foramen on the outer surface of the malar bone, a short distance behind the external margin of the orbit. To expose it the orbicularis palpebrarum must be carefully raised from the bone in an upward direction.

The *infra-orbital nerve* is the terminal part of the superior maxillary division of the trigeminal nerve. It is a large branch which issues from the infra-orbital foramen under cover of the levator labii superioris. It forms, with the facial nerve, a dense plexus, and distributes palpebral, nasal, and labial branches. The *palpebral twigs* turn upwards to supply the skin and conjunctiva of the lower eyelid; the *nasal branches* incline inwards upon the side of the nose; and the *labial branches* run downwards to end in the skin and mucous membrane of the upper lip.

From the *inferior maxillary division of the trigeminal* three nerves are furnished to the face, viz., the auriculo-temporal, which has been described in p. 108; the long buccal nerve; and the mental nerve.

The *long buccal nerve* (n. buccinatorius) will be found coming out from under cover of the anterior border of the masseter muscle. Its branches communicate freely with the facial nerve around the facial vein, and supply the skin and the mucous membrane of the cheek. The latter pierce the buccinator muscle.

The *mental nerve* is a large branch of the mandibular nerve which appears through the mental foramen of the lower jaw under cover of the depressor anguli oris. It communicates with the facial, and supplies the mucous membrane of the lower lip, and the integument of the chin and lower lip. The mental foramen through which the nerve emerges, lies directly below the interval between the two bicuspid teeth.[1]

Arteries of the Face.—There are two main channels concerned in conveying blood to the face, viz. (1) the *transverse facial artery*, a branch of the superficial temporal, and already examined (p. 270); (2) the *facial artery*, a branch of the external carotid. In addition to these a great number of smaller vessels appear on the face with the sensory branches of the trigeminal nerve. Those which accompany the branches of the ophthalmic division are derived from the ophthalmic artery, whilst those associated with the branches of the superior and inferior maxillary divisions proceed from the internal maxillary artery.

Facial Artery (arteria maxillaris externa).—The facial artery will frequently be found smaller than usual. In such

[1] If a line be drawn from the supra-orbital notch to the interval between the two lower bicuspid teeth, and from that onwards to the base of the lower jaw, it will pass over or close to the infra-orbital and mental foramina. This line therefore can be used as a guide in searching for these nerves.

cases its deficiency is compensated for by an increase in the size of the transverse facial, or of some of the other vessels which appear on the face.

The course of the facial artery in the neck has already been noted (p. 256). It enters the face by passing on to the mandible immediately in front of the masseter muscle. It then takes a very tortuous course forwards and upwards to a point a short distance behind the angle of the mouth; from this it ascends to the inner canthus of the eye, and much reduced in size by the numerous branches it has given off, it terminates by anastomosing with the nasal branch of the ophthalmic artery. Throughout its whole length it is comparatively superficial. It is true that it is placed somewhat deeply in the fat of the cheek, but the only muscles which cover it are, from below upwards: the platysma, the risorius, and the zygomaticus major. Its terminal part is usually embedded in the midst of the fibres of the levator labii superioris alæque nasi. The parts upon which it rests as it extends through the face, will be seen to be—(1) the lower jaw; (2) the buccinator; (3) the levator anguli oris; (4) the levator labii superioris. The facial vein does not accompany it closely in the face, but lies, above the level of the lower jaw, at some distance behind it. Several branches of the facial nerve cross it.

Branches of the Facial Artery.—The branches which arise from the facial artery are very numerous. Some of inconsiderable size pass *backwards*. They are distributed to parts in the buccal, masseteric and malar regions, and anastomose with the transverse facial, the buccal, and the infra-orbital arteries. Others proceed *forwards*, and being of larger size, they receive special designations. They are:—

1. Inferior labial.
2. Inferior coronary.
3. Superior coronary.
4. Lateral nasal.
5. Angular.

The *inferior labial* arises immediately above the base of the lower jaw, and is carried forwards under cover of the depressor anguli oris to supply the parts in connection with the chin and lower lip. It anastomoses with the mental, the terminal branch of the submental and the inferior coronary arteries. It is also connected with the corresponding arteries of the opposite side.

The *inferior coronary* takes origin opposite the angle of the mouth, and runs inwards in the lower lip near its free margin between the mucous membrane and the orbicularis oris. In a well injected subject it will be seen shining through the mucous membrane when the lip is everted. It anastomoses with its fellow of the opposite side and with the inferior labial.

The *superior coronary* arises under cover of the zygomaticus major, and is related to the upper lip in the same manner that the inferior coronary is related to the lower lip. It is generally of larger size. It gives off a branch called the *septal artery*, which runs along the lower border of the nasal septum and distributes twigs as far as the tip of the nose.

The *lateral nasal artery* is a branch which is given to the side of the nose, and as a rule passes forwards under cover of the levator labii superioris alæque nasi.

The *angular artery* is the name that is applied to the terminal part of the facial artery. It anastomoses with the nasal branch of the ophthalmic artery.

Facial Vein (vena facialis anterior).—The facial vein begins at the inner canthus of the eye, in a well marked venous trunk called the *angular vein*, which is formed by tributaries coming from the forehead, the upper eyelid and the root of the nose (p. 110). The course which the facial vein takes is not nearly so tortuous as that of the corresponding artery; it lies behind the artery and is separated from it by a considerable interval. Below the malar bone it proceeds in a nearly vertical direction along the anterior

border of the masseter muscle, and at the base of the lower jaw the two vessels come together.

Numerous tributaries join the facial vein as it courses through the face, and a large branch called the *deep facial* connects it with the pterygoid plexus of veins.

The Auricle or Pinna.—Before dissecting the auricle, it is well to learn the names of its various parts, and note the position which they hold in relation to each other. The *concha* is the wide and deep fossa which leads into the external meatus; the *antihelix* is the prominence which bounds this posteriorly; the *helix* is the folded or incurved margin of the pinna; and the *lobule* is its soft dependent

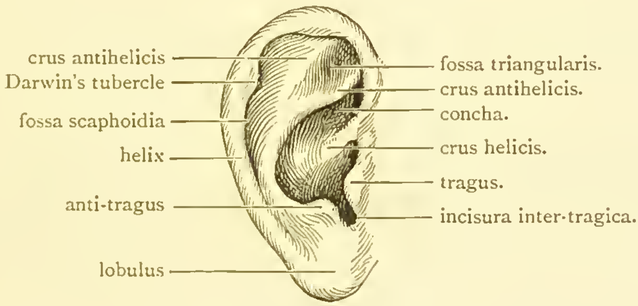

FIG. 229.—The pinna.

part. The concha is partially subdivided into an upper and a lower part by the commencement of the helix, which curves upwards and forwards on its floor to become continuous with the anterior border of the pinna. This portion of the helix is called the *crus helicis.* A small prominence in front of the meatus, and projecting backwards so as to overshadow it, is termed the *tragus*, whilst a similar eminence behind and below the meatus receives the name of the *anti-tragus.* The notch between these two prominences is termed the *incisura inter-tragica.* But it will be noted that the upper end of the anti-helix bifurcates, and in this way two fossæ are marked off from each other; one—*the fossa*

of the helix, or *scaphoid fossa*,—is placed between the helix and the antihelix, and the other—*the fossa of the antihelix*, or *triangular fossa*,—is situated between the two diverging terminal limbs of the antihelix.

The pinna may now be dissected. It consists of a thin plate of yellow fibro-cartilage, covered by integument. It is fixed in position by certain ligaments, and possesses two sets of feeble muscles—viz., one group termed the *extrinsic muscles*, passing to the cartilage from the aponeurosis of the occipito-frontalis and the mastoid process, and a second group, in connection with the cartilage alone, and therefore called the *intrinsic muscles.*

Ligaments, . .	Anterior. Posterior.	
Extrinsic muscles,	Attrahens. Attollens. Retrahens.	Already examined, p. 105.
Intrinsic muscles,	Musculus helicis major. Musculus helicis minor. Musculus tragicus. Musculus anti-tragicus.	Upon the outer face of the cartilage.
	Musculus transversus. Musculus obliquus.	Upon the cranial face of the cartilage.

The skin should be carefully removed from the entire extent of the external auricle. Particular care must be taken in the regions where the intrinsic muscles are placed.

The *auricular cartilage* extends throughout the entire pinna, with the exception of the lobule and the portion between the tragus and the helix. These portions are composed merely of integument, fatty tissue, and condensed connective tissue. The shape of the cartilage corresponds with that of the pinna itself. It shows the same elevations and depressions, and by its elasticity it serves to maintain the form of the auricle. But it also enters into the formation of the cartilaginous or outer portion of the external auditory meatus. By its inner margin this part of the cartilage is firmly fixed by fibrous tissue to the rough outer edge of the auditory process of the temporal bone, and it is deficient above and in front. Here the tube of the meatus is completed by tough fibrous membrane, which stretches between the tragus and the commencement of the helix.

In a successful dissection of the cartilage of the pinna, two other points will attract the attention of the student. The first is a deep slit,

which passes upwards so as to separate the lower part of the cartilage of the helix, termed the *processus helicis caudatus*, from the cartilage of the anti-tragus; the second is a sharp spur of cartilage which projects forward from the helix at the level of the upper margin of the zygoma. This is termed the *spina helicis.*

The *ligaments of the auricle* are two in number. The *anterior auricular ligament* stretches from the spine of the helix to the root of the zygomatic process. The *posterior auricular ligament* will be found under cover of the retrahens auriculam. It is stronger than the preceding, and extends from a slight depression on the cranial aspect of the concha to the mastoid process.

The *intrinsic muscles* of the pinna must be sought for with great care. The helicis minor is not unfrequently absent. The two muscles of the helix, the tragicus and the anti-tragicus, are placed upon the outer face of the cartilage. The transversus and the obliquus lie upon the cranial surface of the pinna.

The *musculus anti-tragicus* is the best marked member of the outer group. It lies upon the outer surface of the anti-tragus, and its fibres pass obliquely upwards and backwards. Some fasciculi can be traced to the processus helicis caudatus.

The *musculus tragicus* is a minute bundle of short vertical fibres situated upon the outer surface of the tragus. When well developed a slender fasciculus may sometimes be observed to pass upwards from it to the fore part of the helix, where it gains insertion into the spine of the helix.

The *musculus helicis major* is a well marked band, which springs from the spina helicis, and extends upwards upon the fore part of the helix, to be inserted into the skin which covers it.

The *musculus helicis minor* is a minute bundle of fleshy fibres which is placed upon the crus helicis as it crosses the bottom of the concha.

The *musculus transversus auriculæ* is found upon the cranial aspect of the pinna. It is generally the most strongly developed muscle of the series, and it consists of fibres bridging across the hollow which, on this aspect of the auricle, corresponds to the antihelix.

The *musculus obliquus auriculæ* is composed of some vertical fasciculi bridging across the depression which corresponds to the eminence of the lower limb of the antihelix.

Eyelids.—The stitches which hold the margins of the eyelids may be removed, but the tow which has been introduced beneath them may be allowed to remain in its place, in order to keep the parts tense during the dissection.

The following strata will be exposed in each eyelid as the student dissects from the surface towards the conjunctiva lining its deep aspect :—

UPPER LID.	LOWER LID.
1. Integument. 2. Palpebral part of the orbicularis palpebrarum. 3. The tarsus, the palpebral ligament, and the expanded tendon of the levator palpebræ superioris. 4. Conjunctiva.	1. Integument. 2. Palpebral part of the orbicularis palpebrarum. 3. The tarsus and the palpebral ligament. 4. Conjunctiva.

In addition to these structures, two ligaments named the *internal and external tarsal ligaments* will be noticed. They attach the tarsal plates to the inner and outer margins of the orbit.

The dissection should be carried on in both eyelids at the same time.

Integument and Orbicularis.—These strata have already been examined, and the skin has been reflected. The *palpebral part* of the orbicularis muscle in each lid forms a thin layer of arching muscular fibres loosely connected with the integument by some lax areolar tissue. A fasciculus, somewhat thicker than the others, lies along the free margin of each lid, close to the bases of the eyelashes. This is termed the *musculus ciliaris*.

Dissection.—The entire orbicularis muscle may now be thrown inwards. This will show very clearly the origin of its muscular fibres at the inner margin of the orbit (p. 271). In raising the palpebral part great care must be taken to preserve the palpebral vessels and nerves, and at the same time to avoid injury to the palpebral ligament.

The Tarsi.—The removal of the palpebral part of the orbicularis brings into view the palpebral ligaments and the tarsal plates. These lie in the same morphological plane, and they constitute the ground-work of the eyelids.

The *tarsi* are two thin plates of condensed connective tissue placed one in each eyelid, so as to occupy an area immediately adjoining its free margin. They differ very materially from each other. The *superior tarsal plate* is much the larger of the two, and presents the figure of a half oval. Its deep surface is intimately connected with the subjacent conjunctiva, whilst its superficial surface is clothed by the orbicularis, and is in relation to the roots of the eyelashes. Its superior border is thin, convex, and continuous with the tendinous expansion of the levator palpebræ superioris. The inferior border of the tarsal plate is thickened and straight, and the integument adheres firmly to it.

The *inferior tarsal plate* is a narrow strip which is similarly placed in the lower lid.

Meibomian Follicles.—At this stage the attention of the student cannot fail to be attracted by the *Meibomian follicles.* To the naked eye they appear as closely-placed, parallel, yellow, granular-looking streaks, which run at right angles to the free margins of the lids. They are more numerous and of greater length in the upper lid, and, being lodged in furrows on the deep surface of the tarsal plates, they are distinctly visible upon both aspects of these, even while the conjunctiva is in position. The ducts open upon the free margin of each lid behind the eyelashes, and by the aid of a magnifying glass they can be seen as round orifices placed in a single row.

The mouths of these glands can be well demonstrated by squeezing the eyelid between the finger and thumb, when the greasy secretion of the glands will be pressed out.

The Palpebral Ligaments are two broad membranous sheets which extend into the basal portions of the eyelids from the upper and lower margins of the orbital opening. They form an incomplete membranous diaphragm around the circumferential part of the orbital opening, termed the

septum orbitale. The *superior ligament* blends along the orbital arch with the pericranium, clothing the frontal bone, and with the periosteum lining the roof of the orbit, whilst inferiorly it blends with the expanded tendon of the levator palpebræ superioris. The *inferior ligament* is continuous on the one hand with the lower margin and anterior aspect of the lower tarsal plate, and on the other with the periosteum of the face and the floor of the orbit. Towards the inner canthus, where the eyelids are supported by the

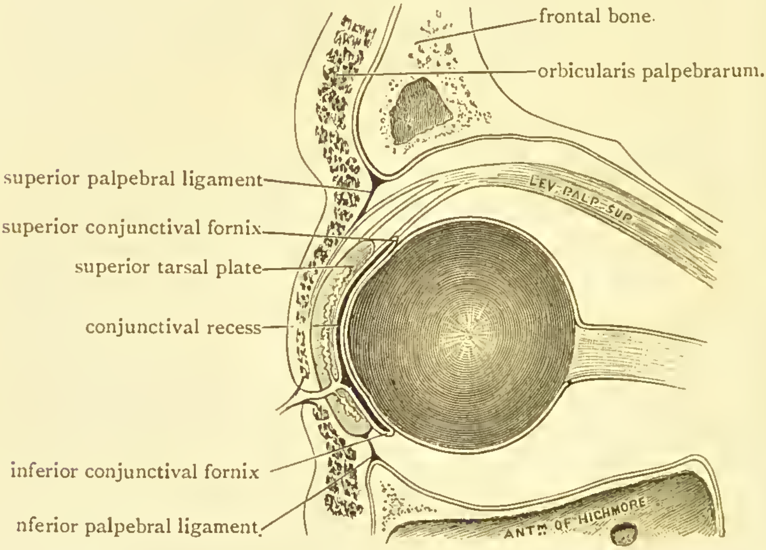

FIG. 230.—Diagram of the structure of the eyelids.

internal tarsal ligament, the palpebral ligaments become thin and delicate.

The Tarsal Ligaments should in the next place be examined. The palpebral ligaments fix the tarsi to the upper and lower margins of the orbit; the tarsal ligaments attach the tarsi to the outer and inner orbital margins.

The *external tarsal ligament* is a narrow band of no great strength, which springs from the malar bone where this forms the outer margin of the orbit and proceeds inwards.

At the outer canthus, it divides into two pieces, an upper and a lower, which are attached to the tarsal plates. This ligament is merely a thickening of the palpebral ligaments where they are continuous with each other at the outer margin of the orbit.

The *internal tarsal ligament* is a much more important structure. It has a double function to perform, viz. (1) to serve as a tendon of origin for the orbicularis muscle, and (2) to fix the tarsi to the inner margin of the orbit. To obtain a satisfactory view of it, the muscular fibres which spring from its upper and lower margins must be completely removed.

The *internal tarsal ligament* is a strong fibrous band which springs from the nasal process of the superior maxillary bone immediately in front of the lachrymal groove. It passes outwards and divides at the inner canthus into two diverging portions which are attached one to each tarsal plate.

The superficial surface of the internal tarsal ligament is covered by the integument; the deep surface crosses the lachrymal sac a short distance above its centre and gives to it a fibrous expansion, which is attached behind to the posterior margin of the lachrymal groove.

Dissection.—The dissection of the lower lid is now completed, but in the case of the upper eyelid the dissector must proceed to detach carefully the superior palpebral ligament from the margin of the orbit, and throw it downwards towards the tarsal plate. This will expose the expanded tendon of the levator palpebræ superioris.

Levator Palpebræ Superioris.—This muscle arises within the cavity of the orbit. Its tendon spreads out into a wide expansion which enters the basal part of the upper eyelid. It is impossible in the course of an ordinary dissection to make out all the very intricate connections of this tendon. It splits into three laminæ. Of these the superficial layer blends with the superior palpebral ligament, and is carried forwards above the tarsal plate to the deep surface of the

palpebral part of the orbicularis muscle. The intermediate stratum, largely composed of involuntary muscular fibres, is inserted into the upper border of the tarsal plate; whilst the deepest lamina is attached to the fornix conjunctivæ (Fig. 230).

Vessels and Nerves of the Eyelids.—At the inner canthus two arteries—the *palpebral branches* of the ophthalmic artery—appear and run outwards in the upper and lower lids. At the outer margin of the orbit, one or more branches of the *lachrymal artery* pierce the palpebral ligament, and anastomose with the palpebral arteries. An arterial arch (*arcus tarseus*) is thus formed close to the margin of each eyelid, between the orbicularis muscle and the tarsal plate.

The *veins* run inwards towards the root of the nose, and open into the frontal and angular veins.

The *nerves* are more numerous, and come from a number of different sources. The motor filaments for the palpebral part of the orbicularis are derived from the facial nerve, and enter the lids at the outer margin of the orbit. The sensory twigs for the upper lid come from the *lachrymal*, *supra-orbital*, *supra-trochlear*, and *infra-trochlear nerves*, whilst the lower lid is supplied by branches from the *infra-orbital nerve*.

Lachrymal Apparatus.—The following structures are included under this heading:—

1. The lachrymal gland and its ducts.
2. The lachrymal canals.
3. The lachrymal sac and the nasal duct.
4. The tensor tarsi muscle.

The Lachrymal Gland lies within the orbit, in the hollow on the roof of this cavity, at the inner side of the external angular process of the frontal bone. The fore-part of the gland projects slightly beyond the orbital margin, and rests upon the conjunctiva of the upper eyelid, as it is reflected from the lid on to the eyeball. If the gland be now raised

gently and the point of the knife carried carefully up and down through the connective tissue under it, several exceedingly delicate ducts, like fine threads, will be seen proceeding from the gland. These vary greatly in number, and they open upon the under surface of the conjunctiva of the upper lid, in the neighbourhood of the fornix or the re-

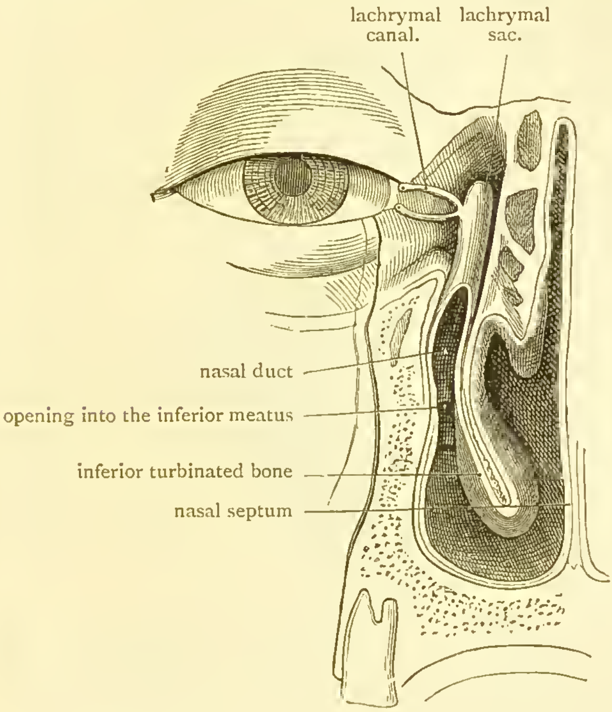

FIG. 231. (From GEGENBAUR.)

flection of this membrane upon the anterior surface of the globe of the eye.

The tears secreted by the lachrymal gland thus reach the under surface of the upper lid, and by the involuntary closure of the lids in winking they are washed over the exposed part of the eyeball and at the same time directed inwards towards the inner canthus. From the lacus lachrymalis they are drained away by the lachrymal canals.

The Lachrymal Canals have in a measure been already examined. The dissector has noted the *puncta lachrymalia*, or the mouths of these minute canals, upon the margins of the eyelids at the inner canthus, and he has endeavoured to determine the course pursued by each, by the introduction of a bristle. The upper canal at first ascends for a short distance, whilst the lower one descends, and then changing their direction suddenly, they both run inwards in relation to the upper and lower margins of the internal tarsal ligament. They open close together into the outer and anterior aspect of the lachrymal sac at a point slightly above its centre. The upper canal is the smaller and longer of the two, and it inclines downwards as well as inwards to reach the lachrymal sac; the lower canal is nearly horizontal in direction.

The Lachrymal Sac is the blind upper and somewhat expanded part of the passage which conducts the tears to the nasal cavity. It is lodged in the deep lachrymal groove in the fore part of the inner wall of the orbit, and it is crossed in front, a short distance above its middle, by the internal tarsal ligament, from the deep surface of which it receives a fibrous expansion. The lachrymal canals open into it under cover of this ligament.

The *nasal duct* is the term which is applied to the lower part of the same passage. It descends in the bony nasal canal, and opens into the fore-part of the inferior meatus of the nose. In length it measures about half-an-inch.

Dissection.—In cases where the dissector is dealing with undissected eyelids, the tensor tarsi muscle can be well exposed from the deep aspect of the lids by dividing them vertically through the middle, and turning the inner portions upwards and downwards. The removal of the conjunctiva at the inner canthus will bring it into view.

The Tensor Tarsi Muscle is a little muscular slip which can now be seen arising from the crest of the lachrymal bone behind the lachrymal sac. Passing outwards and

forwards towards the tarsi, it divides into two slips which blend with the ciliary muscles.

The lachrymal sac, therefore, lies between the internal tarsal ligament and the tensor tarsi, and although anatomists are not quite agreed as to the exact mode of action of this muscle, there can be little doubt that it must be looked

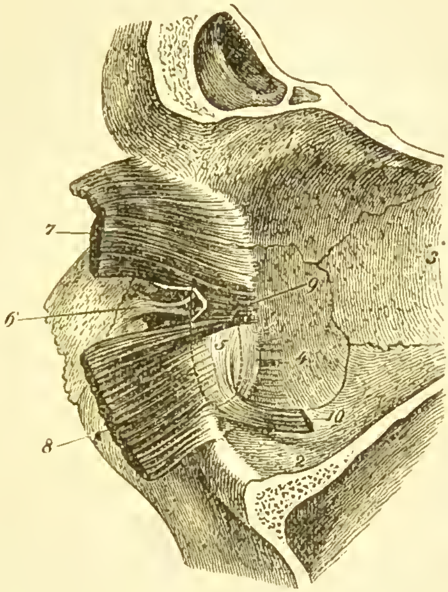

FIG. 232.—The inner wall of the orbit. (From LUSCHKA.)

1. Frontal bone.
2. Superior maxilla.
3. Os planum of the ethmoid.
4. Lachrymal bone.
5. The lachrymal sac covered by its fibrous lamella.
6. Tendo oculi or internal tarsal ligament.
7. The upper and (8) the lower origin of the orbicularis.
9. Tensor tarsi.
10. Origin of the obliquus inferior oculi.

upon as a dependency of the lachrymal apparatus. By its contraction it either aids the propulsion of the fluid through the lachrymal sac, or, by pulling on the tarsal plates, it places the puncta in a more favourable position for the entrance of the tears.

Dissection.—The cartilaginous part of the nose should now be examined by stripping off the compressor naris muscle and the remains of the integument.

The Nasal Cartilages.—In addition to the septal cartilage which will be more appropriately studied in the dissection of the nasal chambers, two cartilaginous plates will be found upon each side. These are :—

1. The upper lateral cartilage.
2. The cartilage of the aperture.

The *upper lateral cartilage* is a triangular plate which by its posterior margin is attached to the lower border of the nasal bone and the upper part of the sharp margin of the

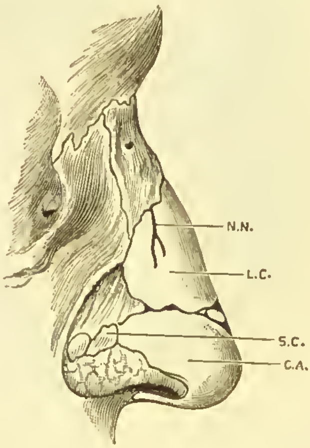

FIG. 233.—Cartilages of the nose.

N.N. Nasal nerve.
L.C. Lateral cartilage.
S.C. Sesamoid cartilages.
C.A. Cartilage of the aperture.

nasal notch of the superior maxillary bone. In the mesial plane this cartilage becomes continuous with its fellow of the opposite side, and also with the subjacent anterior border of the septal cartilage of the nose. Below, there is a slight interval between the two lateral cartilages, in which is seen the margin of the nasal septal cartilage. The inferior border of the lateral cartilage is connected with the outer part of the cartilage of the aperture by some dense fibrous tissue.

The *cartilage of the aperture* is bent upon itself and folded round the orifice of the nostril in front and laterally,—posteriorly it is deficient. The *outer part* is of an oval form, and does not reach down to the margin of the nostril, nor backwards as far as the nasal notch of the superior maxilla The interval between it and the bone is filled in by fibrous tissue in which one or two small islands of cartilage (the cartilagines minores vel sesamoideæ) appear. *In front*, the bent part of cartilage comes into contact with its neighbour and forms the point of the nose. *Internally*, the inner part of the cartilage is in the form of a narrow strip which lies upon the lower part of the septal cartilage, and projects slightly below it so as to support the margin of the nostril upon this side. Its extremity is turned slightly outwards.

THE TEMPORAL AND PTERYGO-MAXILLARY REGIONS.

Under this heading are grouped the parts which are dissected in the temporal and zygomatic fossæ of the skull.

Dissection.—The structures which cover and lie superficial to the temporal fascia have already been examined in the dissection of the scalp (p. 105). They are the superficial fascia, the thin lateral part of the epicranial aponeurosis, the attrahens, and attollens auriculam, and in front the outer part of the orbicularis palpebrarum. Superficial to the fascia there are also numerous nerves and vessels. The *nerves* are the auriculo-temporal, the temporal branches of the facial, and the temporal branch of the temporo-malar. The *vessels* are the superficial temporal artery dividing into its two terminal branches and its accompanying vein. Behind the ear some terminal twigs of the posterior auricular artery will also be seen ascending upon the posterior part of the fascia. All these parts should be carefully gone over a second time, as most of them must now be removed.

Throw the temporal part of the orbicularis palpebrarum forwards ; preserve the middle temporal artery, and the temporal branch of the temporo-malar nerve, both of which pierce the fascia ; turn downwards the other vessels and nerves, and remove what remains of the temporal

part of the epicranial aponeurosis and of the two upper ear muscles. The temporal fascia is in this manner laid bare.

The Temporal Fascia is a strong glistening aponeurosis which is stretched over the temporal fossa, and binds down the muscle of the same name. Its upper margin is attached to the upper of the two rough lines which constitute the temporal ridge on the lateral aspect of the skull, and in front to the temporal crest of the frontal bone. As it approaches the zygomatic arch, it splits into two laminæ, which are separated from each other by a narrow interval filled with fat. These are attached to the outer and inner margins of the upper border of the zygomatic arch, and to the posterior border of the malar bone. They can readily be demonstrated by dividing the superficial layer close to its attachment, and throwing it upwards; by the handle of the knife the attachment of the deep layer can then be made out. In the upper part of its extent, the temporal fascia is comparatively thin, and the fibres of the subjacent muscle may be seen shining through it; below it is thicker, and owing to the fat which is interposed between its laminæ, it becomes perfectly opaque.

Dissection.—The masseter muscle must now be thoroughly cleaned. To do this effectually, it will be necessary to divide the trunk of the *facial nerve* immediately beyond the point where it gives off the branches to the digastric and stylo-hyoid muscles, and throw it forwards, with the various branches which spring from it, towards the buccal region. The *transverse facial* artery must be likewise turned backwards. The dissector will recollect that he has previously removed from the surface of the masseter a forward prolongation of the parotid gland, the socia parotidis, Stenson's duct, twigs from the great auricular nerve, scattered fibres of the platysma, and the origin of the risorius muscle.

The Masseter is a massive quadrate muscle which lies upon the ascending ramus of the lower jaw. Its fibres are arranged in two sets—a superficial and a deep. The *superficial part* of the muscle arises from anterior two-thirds of the lower border of the zygomatic arch, and its fasciculi are directed downwards and backwards. The *deep part* springs

from the whole length of the inner aspect of the zygomatic arch, and also from the posterior third of its lower border. Its fibres proceed downwards and forwards. The only portion of the deep part which appears on the surface is a small piece at the upper and back part of the muscle. The masseter is inserted into the outer surface of the ascending ramus of the mandible, over an area which extends downwards to the angle, and upwards so as to include the outer aspect of the coronoid process.

Dissection.—A dissection must now be undertaken to display the temporal muscle, and at the same time expose the nerve and artery of supply to the masseter. Begin by dividing the temporal fascia along the upper border of the zygomatic arch. It may then be thrown upwards and completely removed. The middle temporal artery, and the temporal branch of the temporo-malar nerve which pierce it must be disengaged from it and preserved. The zygomatic arch with the attached masseter must next be thrown down by dividing the bony arch in front and behind the origin of the muscle. First make use of the saw, and then complete the division by means of the bone-pliers. The posterior cut should be made immediately in front of the glenoid fossa, and the head of the lower jaw ; the anterior cut must extend obliquely through the malar bone, from the extreme anterior end of the upper margin of the arch, downwards and forwards to the point where the lower margin meets the malar process of the superior maxillary bone. In this way the whole of the masseteric origin is included between the incisions, and the arch with the attached muscle may be readily thrown downwards towards the angle of the lower jaw. The fleshy origin of the deep portion of the masseter from the inner surface of the zygomatic arch can now be seen, and frequently the dissection is complicated by a number of fibres from the temporal muscle joining this part of the masseter. In turning the masseter down, great care must be taken not to injure its nerve and artery of supply. These pass outwards through the sigmoid notch, between the neck of the lower jaw and the posterior margin of the temporal muscle. When they are exposed and cleaned, they must be divided in order that the muscle may be fully reflected. On no account detach the masseter from the angle of the jaw. The temporal muscle may now be cleaned.

The Temporal Muscle (musculus temporalis) is fan-shaped. It arises from the entire extent of the temporal fossa by an origin reaching upwards as high as the lower of the two lines

which constitute the temporal ridge, and downwards as low as the zygomatic crest of the great wing of the sphenoid. It also receives additional fibres from the deep surface of the temporal fascia which covers it. From this broad origin the fasciculi of the temporal muscle converge towards the coronoid process of the lower jaw. The anterior fibres descend vertically, the posterior fibres at first pursue a nearly horizontal course, whilst the intermediate fasciculi proceed with varying degrees of obliquity. As it approaches its insertion, a tendon is developed upon its superficial aspect, and this is inserted into the summit and anterior edge of the coronoid process of the mandible. The deep part of the muscle remains fleshy, and gains attachment to the inner surface of the same bony prominence by an insertion which reaches as low down as the point where the anterior margin of the ramus merges into the body of the mandible.

Dissection.—The next step in the dissection of this region consists in separating the coronoid process from the mandible, and turning it upwards with the attached temporal muscle. A very oblique cut is required; it should extend from the centre of the sigmoid notch above, downwards and forwards, to the point where the anterior margin of the ascending ramus meets the body of the mandible. First use the saw, and then complete the division with the bone-pliers. The *long buccal nerve* and its companion *artery* are in a position of great danger during this dissection, and must be carefully guarded. They proceed downwards and forwards under cover of the lower part of the temporal muscle, and not unfrequently the nerve will be found traversing its substance. The coronoid process and the temporal muscle should be thrown well upwards, and the muscular fibres separated by the handle of the knife from the bone forming the lower part of the temporal fossa. This will bring into view the *deep temporal nerves* and *arteries* as they ascend between the cranial wall and the muscle. This is the time also to follow the *middle temporal artery.* It will be noticed to give branches to the muscle and extend upwards upon the squamous part of the temporal bone. The *temporal branch* of the *temporo-malar nerve* should likewise be traced to the point where it emerges from the minute aperture on the temporal surface of the malar bone. At this point it lies under cover of the temporal muscle.

The pterygoid region may now be fully opened up by removing a

portion of the ascending ramus of the mandible. Two horizontal cuts must be made; one through the neck of the mandible, and the other immediately above the level of the inferior dental foramen. To find the level of the latter, the handle of the forceps should be thrust forwards between the ramus and the subjacent soft parts, and carried downwards. Its progress will soon be arrested by the entrance of the inferior dental vessels and nerve into the foramen, and the lower border of the instrument will correspond with the line along which the bone should be cut. Both incisions should be made with the saw, until the outer table of the bone is cut through, and then the bone-pliers may be employed to complete the division.

Parts displayed by the above Dissection.—When the fat and areolar tissue are removed, the pterygoid muscles will come into view. The *external pterygoid* will be recognised from its extending horizontally backwards to the neck of the mandible. The *internal pterygoid*, embracing the anterior part of the external pterygoid muscle between its two heads of origin, proceeds downwards and backwards upon the deep surface of the ramus of the mandible. It bears very much the same relation to the inner aspect of the ascending ramus, that the masseter presents to its superficial surface. The great blood vessel of the space—the *internal maxillary artery*—proceeds forwards upon the external pterygoid muscle. The *nerves* will also be observed to be placed in close relationship to the same muscle. Thus, emerging from between its upper border and the cranial wall at the level of the infra-temporal crest are the *masseteric* and the two *deep temporal nerves;* appearing from under cover of its lower border are the *mandibular* and the *lingual nerves;* whilst the *auriculo-temporal nerve* is related to it behind, and the *long buccal nerve* in front. The former passes backwards under cover of its insertion, and appears behind the temporo-maxillary joint, and the long buccal either pierces it or emerges from between its two heads of origin. The *internal lateral ligament* of the lower jaw will likewise be seen. It is the thin strip of membrane upon which the inferior dental or mandibular nerve rests.

The External Pterygoid Muscle (musculus pterygoideus externus) arises in the zygomatic fossa by two heads, an upper and a lower. The *upper head* springs from the infratemporal ridge and the zygomatic surface of the great wing of the sphenoid; the *lower head* takes origin from the outer surface of the external pterygoid plate. As the muscle passes backwards it diminishes somewhat in width, and is

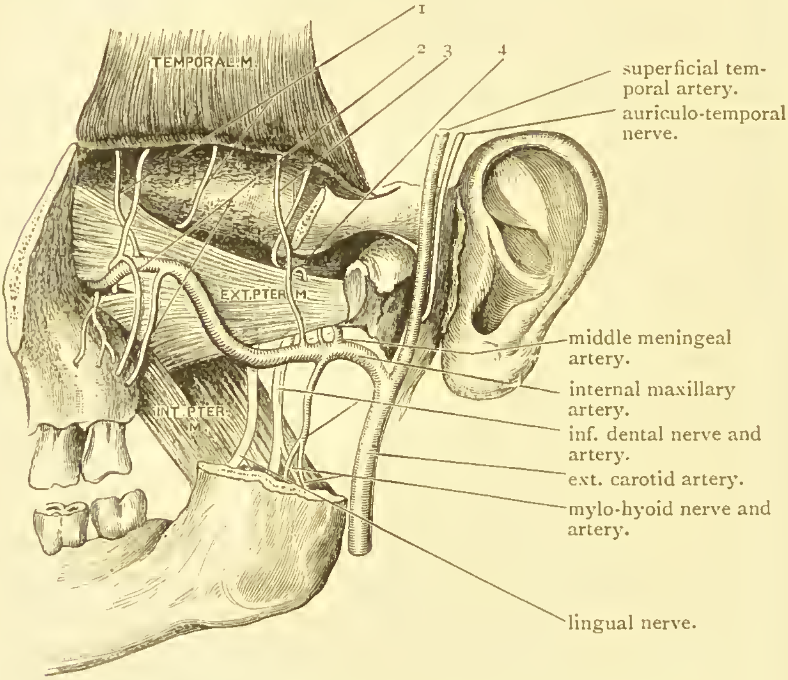

FIG. 234.—Dissection of the pterygo-maxillary space.

1. Ant. deep temporal nerve and artery.
2. Long buccal nerve and artery.
3. Post. deep temporal nerve and artery.
4. Masseteric nerve.

inserted into the fore part of the neck of the mandible, and also into the anterior margin of the interarticular fibrocartilage of the temporo-maxillary articulation.

The Internal Pterygoid Muscle (musculus pterygoideus internus) is also bicipital at its origin. Its two heads embrace the origin of the lower head of the external pterygoid.

The *superficial* and smaller head of the internal pterygoid springs from the lower and baek part of the tuberosity of the superior maxilla and also from the outer surfaee of the tuberosity of the palate bone ; the *deep head*, hidden by the external pterygoid, arises in the pterygoid fossa from the inner surfaee of the external pterygoid plate, and from the surface of the tuberosity of the palate bone, whieh appears between the two pterygoid plates. The two heads of the musele unite at the lower margin of the fore part of the external pterygoid, and its fibres proceed downwards with an inclination baekwards and outwards. They gain insertion into the angle of the lower jaw, and into the lower and baek part of the inner aspeet of the aseending ramus as high as the mandibular foramen.

The Internal Maxillary Artery (arteria maxillaris interna) is the larger of the two terminal branches of the external earotid artery, and takes origin within the substance of the parotid gland, immediately behind the neck of the mandible. From this it proceeds forwards to the fore part of the zygomatic fossa, where it disappears from view, by dipping between the two heads of origin of the external pterygoid muscle, and entering the spheno-maxillary fossa. It is customary to divide it into three parts for convenienee in description. The *first part* runs horizontally forwards under cover of the neck of the mandible, and upon the internal lateral ligament. It lies along the lower border of the posterior part of the external pterygoid muscle, and usually erosses the inferior dental nerve. The *second part* extends obliquely upwards and forwards upon the surface of the external pterygoid musele, and under cover of the insertion of the temporal musele into the coronoid proeess of the mandible. The *third part* dips between the two heads of the external pterygoid, and is contained in the spheno-maxillary fossa.

Whilst this is the most frequent arrangement, it is by no means uneommon to find the seeond part of the artery lying in a deeper plane, viz., between the internal and ex-

ternal pterygoid muscles. In this case the vessel makes a bend outwards between the heads of the external pterygoid muscle, and appears on its surface before entering the spheno-maxillary fossa.

The *branches* of the internal maxillary artery are classified into three groups according to the portion of the vessel from which they spring. One branch only of the third part, viz., the *posterior dental* or the *superior posterior alveolar artery*, can be studied in this dissection. Those arising from the first and second parts are :—

From the First Part.	From the Second Part.
1. The deep auricular. 2. Tympanic. 3. Middle meningeal. 4. Small meningeal. 5. Inferior dental.	1. Masseteric. 2. Pterygoid. 3. Anterior and posterior deep temporal. 4. Buccal.

The *deep auricular artery* (arteria auricularis profunda) is a small vessel which pierces the anterior wall of the external auditory meatus to supply the skin which lines it and also the superficial part of the tympanic membrane.

The *meningeal and tympanic* branches proceed upwards under cover of the external pterygoid muscle, and therefore cannot be fully studied until this muscle is reflected.

The *inferior dental artery* (arteria alveolaris inferior) arises opposite the middle meningeal, and runs downwards upon the internal lateral ligament to enter the mandibular foramen of the lower jaw. It is generally accompanied by two venæ comites, which lie one upon either side of it, and it is placed behind the inferior dental nerve. Just before entering the canal, the inferior dental artery gives off the slender *mylo-hyoid branch*, which is carried downwards and forwards with the corresponding nerve, upon the deep aspect of the mandible, to the digastric triangle of the neck.

The branches from the second part are given off for the supply of the neighbouring muscles. The *masseteric* (arteria masseterica) passes outwards behind the temporal muscle with the nerve of the same name, and has been seen entering the masseter muscle. The *pterygoid branches* (rami pterygoidei) are a few irregular twigs, which are given to the pterygoid muscles. The *deep temporal arteries* (arteriæ temporales profundæ) are two in number — anterior and posterior—and pass upwards in the fore and hinder part of the temporal fossa, between the bony wall of the cranium and the temporal muscle. They end in twigs for the supply of the temporal muscle, and anastomose with the middle temporal artery. The *buccal artery* (arteria buccinatoria) accompanies the long buccal nerve, and is distributed to the buccinator muscle and the mucous membrane of the cheek. It anastomoses with the facial artery.

The *posterior dental branch* (arteria alveolaris superior posterior), from the third part of the internal maxillary artery, descends upon the posterior aspect of the superior maxilla, and sends branches through the posterior dental foramina for the supply of the upper molar and bicuspid teeth (Fig. 234). Some small twigs also go to the gum, whilst others find their way to the lining membrane of the antrum of Highmore.

Pterygoid and Internal Maxillary Veins.—The veins in this region are very numerous, but they cannot be studied satisfactorily in an ordinary dissection. They are well seen, however, when injected, in horizontal sections of the frozen head made at the level of the external pterygoid muscle. They constitute a dense plexus, termed the *pterygoid plexus*, around the external pterygoid muscle. Tributaries corresponding to the branches of the internal maxillary artery open into this network, whilst the blood is led away from its back part by a short wide trunk, called the *internal maxillary vein*. This vessel accompanies the first part of the internal maxillary artery into the parotid gland, and joins

the superficial temporal vein behind the neck of the jaw, to form the temporo-maxillary trunk.

The pterygoid venous plexus also establishes by various offsets, certain highly important connections. From its fore part the *deep facial vein* proceeds; this extends forwards under cover of the lower jaw and the masseter, and unites with the facial vein. Entering its upper part are one or more minute emissary veins from the cavernous sinus. These gain the exterior of the cranium by passing through the foramen ovale. It likewise communicates with the ophthalmic vein through the spheno-maxillary fissure.

Temporo-Maxillary Articulation (articulatio mandibularis).—This joint must next be studied, in order that the external pterygoid muscle may be thrown forwards. In connection with it we find—

Ligaments Proper.	Accessory Ligaments.
1. The external lateral.	1. Internal lateral.
2. The capsular.	2. Stylo-maxillary.
An interarticular fibro-cartilage.	

The *external lateral ligament* is a strong band which is attached above to the outer surface of the posterior part of the zygomatic arch and to the tubercle at the root of the zygoma. It is composed of short parallel fibres, which proceed obliquely downwards and backwards to be inserted into the outer and hinder part of the neck of the lower jaw.

The *capsule* of the joint consists of a few scattered fibres, which support the synovial membranes upon the inner, anterior, and posterior aspects of the articulation.

The *internal lateral ligament* is a long membranous band which springs from the spinous process of the sphenoid, and is attached below to the lingula and to the sharp inner margin of the mandibular foramen. It is not in direct

relationship with the joint. Above, it lies under cover of the external pterygoid muscle; lower down, the internal maxillary artery intervenes between it and the neck of the mandible; whilst, still lower, the inferior dental vessels and nerve are interposed between it and the ramus of the mandible.

The *stylo-maxillary ligament* has already been noticed. It is an aponeurotic band, derived from the deep cervical fascia, which is attached on the one hand to the styloid process, and on the other to the angle and posterior border of the ramus of the jaw between the internal pterygoid and masseter muscles.

An examination of these ligaments will show that very little is added to the strength of the joint by their presence. The security of the joint depends not so much upon its ligaments as upon the strong muscles of mastication, which keep the head of the mandible in its place.

The *interarticular fibro-cartilage* is an oval plate, with its long axis directed transversely. It is interposed between the condyle of the mandible and the glenoid cavity, and divides the joint cavity into an upper and lower portion, each of which is provided with a separate synovial membrane. To expose the cartilage, the external lateral ligament must be removed. It will then be seen to be adapted to the two bony surfaces between which it lies. Above, it is concavo-convex in correspondence with the eminentia articularis and the glenoid fossa of the temporal bone; whilst, below, it is concave, and fits upon the upper aspect of the condyle of the mandible. In the centre it is thin, and in some cases may be seen to be perforated. Its circumference, more especially posteriorly, is thick. It should also be noted that it is but loosely attached by its periphery to the external lateral ligament, and that anteriorly the external pterygoid muscle is partly inserted into it.

The *synovial membrane* which lines the upper cavity of the joint, is of greater extent and looser than that which

lines the lower compartment. This is owing to the articular surface of the temporal bone being of larger size than the condylar surface.

Movements.—The movements which the mandible can perform at the temporo-maxillary joint are the following:—(1) depression; (2) elevation; (3) protraction; (4) retraction; (5) lateral or chewing movements. When the lower jaw is depressed the interarticular fibro-cartilage with the condyle of the mandible moves forwards in the glenoid fossa, and the latter finally takes up a position on the eminentia articularis. This forward gliding of cartilage and condyle in the upper compartment of the joint is accompanied by another movement in the lower compartment of the joint, which consists in a rotation of the

FIG. 235.—Diagram of the different positions occupied by the head of the mandible and the inter-articular cartilage as the mouth is opened and closed.

condyle of the mandible on the lower surface of the interarticular fibro-cartilage. Elevation of the mandible or closure of the mouth is brought about by a reverse series of changes in both compartments of the joint. Whilst these movements are going on the mandible rotates around a transverse axis which traverses the bone in the neighbourhood of the mandibular foramen. This is the point, therefore, of least movement, and consequently in opening and shutting the mouth the inferior dental vessels and nerves are not unduly stretched. In protraction and retraction the movement is chiefly confined to the upper compartment of the joint. The condyle of the mandible with the interarticular fibro-cartilage glides forwards and backwards upon the temporal articular surface. In the lateral movements of the jaw the mandible is carried alternately from side to side, as in the process of chewing.

The muscles on each side which are chiefly engaged in producing these movements are the following:—(1) *depressors*—the platysma, the mylo-hyoid, and the anterior belly of the digastric; (2) *elevators*—the masseter, internal pterygoid, temporal; (3) *protractors*—the external pterygoid, and to some extent the internal pterygoid and the superficial fibres of the masseter; (4) *retractor*—the posterior fibres of the temporal; (5) *lateral movement* is produced by certain of the muscles of opposite sides acting alternately.

Reflection of External Pterygoid.—The head of the lower jaw should now be disarticulated and thrown forwards with the attached external pterygoid muscle. It is well to detach the interarticular fibro-cartilage with the head of the bone, in order that it may be more thoroughly examined. Great care must be taken not to injure the auriculo-temporal nerve, which passes backwards in close proximity to the deep aspect of the joint. When the disarticulation is complete, the muscle may be turned forwards by gently insinuating the head of the jaw under the internal maxillary artery.

The reflection of the external pterygoid muscle brings into view, after a little dissection, the *inframaxillary division* of the *trigeminal nerve*, emerging from the foramen ovale, and breaking up into its branches of distribution. The slender *chorda tympani* will likewise be found proceeding downwards and forwards to join the lingual nerve, and the *middle meningeal*, *tympanic*, and *small meningeal arteries* may be traced to the points where they leave the space.

Middle and Small Meningeal and Tympanic Arteries.—The *middle meningeal artery* (arteria meningea media) has already been seen arising from the first part of the internal maxillary artery. It proceeds upwards under cover of the external pterygoid muscle, and disappears from view by entering the foramen spinosum, and thus gaining the cranial cavity (p. 133). It will generally be observed to be embraced by the two heads of origin of the auriculo-temporal nerve.

The *small meningeal* (ramus meningeus accessorius) and *tympanic* (arteria tympanica) *arteries* arise more frequently from the preceding vessel than from the trunk of the internal maxillary. The *small meningeal* inclines forwards and upwards, and enters the cranial cavity by passing through the foramen ovale; the *tympanic* runs

upwards and slightly backwards, and reaches the tympanum by passing through the Glaserian fissure. In the tympanic cavity it anastomoses with the stylo-mastoid branch of the posterior auricular artery.

Inferior Maxillary Division of the Trigeminal Nerve. The inferior maxillary nerve arises within the cranium from

FIG. 236.—Diagram of the infra-maxillary division of the fifth cranial nerve.

a. Sensory root entering the Gasserian ganglion.
b. Motor root.
c. Ophthalmic division.
d. Superior maxillary division.
e. Inferior maxillary division passing through the foramen ovale.
f. Nerve to the internal pterygoid.
g. Anterior division.
h. Recurrent branch.
i. Middle meningeal artery.
k. Foramen spinosum.
l. Auriculo-temporal nerve.
m. Chorda tympani.
n. Posterior division.
o. Lingual nerve.
p. Mylo-hyoid nerve.
r. Inferior dental nerve.

the Gasserian ganglion, and enters the pterygo-maxillary region through the foramen ovale. It is composed of *sensory fibres*, but it is accompanied through the foramen by the small *motor root* of the trigeminal nerve, and, a junction being effected between the two, immediately after

they gain the exterior of the cranium, a *mixed nerve trunk* is the result. This nerve-trunk lies under cover of the external pterygoid muscle, and after a very short course (not exceeding two or three lines) it ends by dividing into two parts, named respectively the *anterior* and *posterior divisions* of the inferior maxillary nerve (Fig. 236).

Before it divides, the trunk of the inferior maxillary nerve gives off two branches, viz. (1) the recurrent nerve (nervus spinosus) (*h*), and (2) the nerve to the internal pterygoid muscle (*f*).

The *recurrent nerve* is a very slender twig which enters the cranium by accompanying the middle meningeal artery through the foramen spinosum. It is distributed to the lining membrane of the mastoid cells and to the great wing of the sphenoid bone.

The *internal pterygoid nerve* will be found passing under cover of the posterior border of the internal pterygoid muscle close to its origin. In close relation to the root of this nerve is the *otic ganglion*.

From the two terminal divisions of the inferior maxillary trunk the chief branches of distribution arise. The *small anterior division* is much the smaller of the two, and is composed almost entirely of motor fibres derived from the motor root of the trigeminal nerve. The only sensory fibres which it contains are those which form the *long buccal nerve*. It gives off the following branches :—

1. Masseteric.
2. Two deep temporal.
3. External pterygoid.
4. Long buccal.

The *large posterior division* is chiefly sensory. It contains only a very few fibres from the motor root, and these are prolonged into its inferior dental branch, and afterwards come off in the form of the *mylo-hyoid nerve*. The branches of the posterior division are :—

1. Auriculo-temporal.
2. Inferior dental (or mandibular).
3. Lingual (or gustatory).

The *masseteric nerve* is directed outwards above the external pterygoid muscle, and, passing through the sigmoid notch behind the posterior border of the temporal muscle, it enters the hinder and upper part of the deep surface of the masseter. In the substance of this muscle it may be traced with the companion artery downwards and forwards to its lower and fore part. Before reaching the masseter, it gives one or two twigs to the temporo-maxillary joint.

The *deep temporal nerves* are usually two in number, and are termed *anterior* and *posterior* according to the position they occupy in the temporal fossa. The *posterior nerve* is the smaller of the two, and frequently arises by a common root with the masseteric. Both deep temporal nerves pass outwards above the external pterygoid and then turn upwards upon the bony wall of the cranium. After a short course they end in twigs which penetrate the substance of the temporal muscle.

The Long Buccal Nerve (nervus buccinatorius) is the largest of the branches proceeding from the anterior division of the inferior maxillary nerve. It proceeds outwards between the two heads of the external pterygoid muscle and then runs downwards and forwards under cover of the temporal muscle, and also of the anterior border of the masseter, to reach the outer surface of the buccinator muscle. Here it has been seen to form with branches of the facial nerve *the buccal plexus*, and to be distributed to the mucous membrane and skin of the cheek (p. 288).

The long buccal is a sensory nerve, and all the sensory fibres in the anterior division of the inferior maxillary nerve enter into its composition. A few motor fibres, however, are also prolonged into it; these come off from it in two branches, viz. (1) in the *nerve to the external pterygoid*, which as a rule arises in common with the long buccal and at once sinks into the deep surface of this muscle; and (2) in a third twig of supply to the temporal muscle. This *temporal branch* springs from the long buccal after it has

reached the outer surface of the external pterygoid, and proceeds upwards to supply the fore part of the temporal muscle (Fig. 234). In some cases the long buccal nerve may be observed to pierce the temporal muscle instead of passing under cover of it.

The Auriculo-Temporal Nerve, composed of sensory fibres, springs from the posterior division of the inferior maxillary by two roots. These pass backwards under cover of the external pterygoid muscle and embrace the middle meningeal artery. Beyond this vessel they unite, and the nerve is continued backwards under cover of the neck of the lower jaw, immediately below the temporo-maxillary joint. Gaining the interval between the ear and jaw it turns upwards in relation to the deep surface of the parotid gland, and crosses the zygoma in company with the superficial temporal artery. Its further course has already been examined (p. 108).

The following branches proceed from it:—(1) one or two strong branches of communication to the temporo-facial nerve; (2) a few slender filaments which enter the posterior aspect of the temporo-maxillary joint; (3) some twigs to the parotid gland; (4) terminal filaments to the skin over the temporal region and summit of the head (p. 108); (5) auricular branches.

The *auricular* branches are usually *two* to the skin lining the interior of the external auditory meatus and *two* to the integument over the upper and fore part of the pinna. The former gain the interior of the meatus by passing between the osseous and cartilaginous portions of the canal.

The Inferior Dental Nerve (nervus mandibularis) is the largest branch of the inferior maxillary. Emerging from under cover of the external pterygoid muscle it passes downwards upon the internal lateral ligament of the lower jaw and enters the mandibular foramen. The inferior dental artery runs downwards behind it, whilst the lingual nerve is in front of it and upon a somewhat deeper plane.

The inferior dental is a sensory nerve, but a few motor fibres from the motor root are prolonged downwards within its sheath as far as the mandibular foramen. At this point they come off as the slender *mylo-hyoid* nerve.

The *mylo-hyoid nerve*, accompanied by the artery of the same name, pierces the internal lateral ligament and proceeds downwards and forwards in a groove upon the deep surface of the lower jaw to the submaxillary triangle. A narrow prolongation of the internal lateral ligament bridges over the groove and holds the nerve and vessel in position. In the submaxillary triangle the mylo-hyoid nerve has already been dissected. It appears upon the surface of the mylo-hyoid muscle, and, issuing from under cover of the superficial part of the submaxillary gland, it breaks up into numerous branches for the supply of two muscles, viz. (1) the mylo-hyoid, and (2) the anterior belly of the digastric.

Lingual Nerve.—This nerve is entirely sensory, and is covered in the first part of its course, like the other branches of the inframaxillary nerve, by the external pterygoid muscle. Appearing at the lower border of this muscle, it proceeds downwards and forwards between the internal pterygoid muscle and the mandible and enters the submaxillary region, where it will afterwards be traced to the tongue. It is placed in front of and on a slightly deeper plane than the inferior dental nerve. In this region it gives off no branches, but, under cover of the external pterygoid, it is joined at an acute angle by the *chorda tympani branch* of the facial nerve. Very frequently, also, a communicating twig passes between it and the inferior dental nerve.

The Chorda Tympani is a slender nerve which arises from the facial in the aqueduct of Fallopius. It gains the pterygo-maxillary region by traversing the tympanic cavity and appearing through the inner part of the Glaserian fissure. It will now be seen to run downwards and forwards under cover of the internal lateral ligament of the lower

jaw, and unite with the lingual nerve near its origin. It is joined by a slender filament from the otic ganglion.

Otic Ganglion.—As this ganglion lies under cover of the inferior maxillary trunk, it cannot be satisfactorily studied at this stage. It is true that it may be exposed by tracing the nerve to the internal pterygoid muscle upwards, when it will be seen to be developed in connection with the root of this branch. Its connections, however, can only be made out by dissecting from the inside, and it is well to defer its examination until this can be done.

Dissection.—The student should now endeavour, by means of a Hey's saw, a chisel, and the bone-pliers, to remove the outer table of the lower jaw, and thus open up the mandibular canal.

Structures within the Mandibular Canal.—This canal is traversed by the *inferior dental artery and nerve.* These give off twigs which enter the fangs of the molar and bicuspid teeth, and they each terminate by dividing into a mental and incisor branch.

The *mental artery and nerve* appear on the face through the mental foramen, and have already been examined; the *incisor artery and nerve* are carried forwards to the symphysis and send up twigs to the canine and incisor teeth. The vessel anastomoses in the bone with the corresponding artery of the opposite side.

SUBMAXILLARY REGION.

The superficial area of the submaxillary region has already been dissected, under the name of the anterior part of the digastric or submaxillary triangle (p. 220). It is now necessary to carry the dissection to a deeper plane, in order to expose a number of parts in connection with the tongue and floor of the mouth. The structures thus displayed are :—

1. Mylo-hyoid muscle.
2. Submaxillary gland and its duct.
3. Sublingual gland.
4. Side of the tongue, and the mucous membrane of the mouth.
5. Muscles. { Hyo-glossus. Stylo-glossus. Genio-hyoid. Genio-hyo-glossus
6. Nerves. { Hypoglossal. Lingual. Glosso-pharyngeal.
7. Submaxillary ganglion.
8. Lingual artery and veins.
9. Stylo-hyoid ligament.

Dissection.—To prepare the part for dissection, it is necessary to throw back the head to its full extent, and turn it slightly to the opposite side. If the stuffing in the mouth has not been previously removed in the dissection of the pterygo-maxillary region, it should be taken out now, and then the tip of the tongue should be seized with the forceps, and drawn forcibly forwards between the teeth, and retained in this position by stitching it to the nose.

In dissecting towards the mesial plane, three muscular strata are encountered, viz., the mylo-hyoid, the hyo-glossus, the genio-hyo-glossus. In the intervals between these, certain important structures will be exposed. Begin with the first muscular stratum.

The *mylo-hyoid muscle* forms the fore part of the floor of the digastric triangle. To bring it fully into view, certain of the contents of this space must be displaced. Divide the facial artery at the point where it gains the lower jaw, and, disengaging it from the submaxillary gland, throw it downwards, along with its submental branch and the facial vein. Next, detach the anterior belly of the digastric from the mandible, and deal with it in the same manner. The mylo-hyoid nerve must also be cut, and the superficial part of the submaxillary gland turned backwards. The superficial surface of the mylo-hyoid is in this way completely exposed, and its fibres may be cleaned and its attachments made out.

The Mylo-hyoid (musculus mylohyoideus) is a thin sheet of muscular fibres, which arises from the mylo-hyoid ridge upon the deep surface of the body of the mandible by an origin which extends from the last molar tooth behind to the symphysis in front. Its fibres are directed downwards,

inwards, and backwards, and present two different modes of insertion. The posterior fibres are inserted into the body of the hyoid bone; these, however, form a comparatively small part of the muscle. The greater number of the fibres are inserted into a median raphe, which extends between the symphysis of the lower jaw and the body of the hyoid bone. The two mylo-hyoid muscles, therefore, in front of

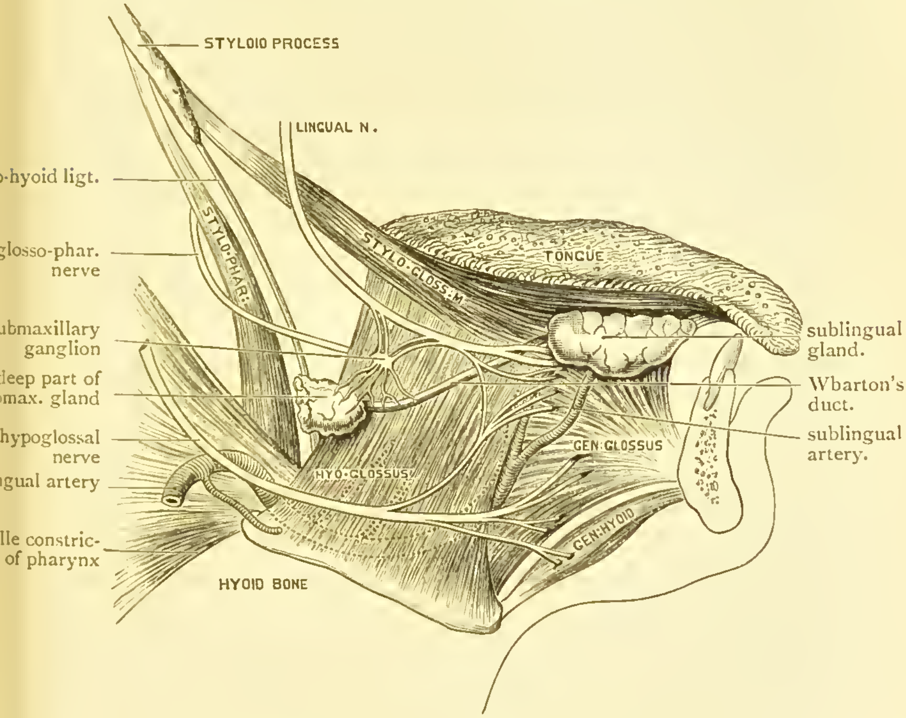

FIG. 237.—Dissection of the submaxillary space.

the hyoid bone stretch across from one side of the body of the mandible to the other, and constitute a floor for the anterior part of the mouth. This floor is frequently termed the *diaphragma oris*. The mylo-hyoid muscle is supplied by the mylo-hyoid branch of the inferior dental nerve.

Dissection.—The mylo-hyoid muscle must now be reflected, in order that the parts subjacent to it may be brought into view. As these parts

lie in a great measure under shelter of the mandible, it is advantageous to make at the same time a section of this bone, in order that it may be turned upwards.

Carefully divide the fibres of the mylo-hyoid muscle close to the ridge from which it arises. A very small piece may be left attached to the mandible to serve as a landmark in the future dissection. This must be done very cautiously, else the mucous membrane of the mouth will be injured. When detached from the jaw, the muscle must next be separated from the median raphe, and then it can be thrown down over the hyoid bone. The lower jaw should next be divided, by means of the saw and bone-pliers, a quarter of an inch to the outer side of the symphysis. When the section is completed, the lower margin of the mandible should be gently tilted upwards, and some means taken to retain the loose piece of the bone in this position. Under no pretence whatever should it be removed, and great care must be taken to preserve intact the mucous membrane passing from the floor of the mouth to the deep surface of the gum.

Parts Exposed by the Reflection of the Mylo-hyoid (Fig. 237).—The side of the tongue is now brought into view, with a number of structures in connection with it. First note the mucous membrane stretching from the tongue to the gum of the lower jaw; then identify the various muscles. The *hyo-glossus*, a portion of which was previously visible behind the mylo-hyoid, is fully exposed. It is a square sheet of fleshy fibres which extends from the hyoid bone to the side of the tongue. Mark its position, because all the structures in this region have a more or less intimate relattionship to it. Thus, behind it, will be recognised the *stylo-glossus muscle*, and in front of it, the *genio-hyo-glossus* and the *genio-hyoid.* The genio-hyoid muscle occupies the fore part of the region, whilst the anterior part of the genio-hyo-glossus is seen in the interval between it and the hyo-glossus. Upon the surface of the hyo-glossus, the lingual and hypoglossal nerves, the deep portion of the submaxillary gland with Wharton's duct, and the submaxillary ganglion are to be dissected. The *lingual nerve* occupies the highest level, and passes forward upon the muscle near its insertion into the tongue. The *hypoglossal nerve*, accompanied by the *ranine*

vein, crosses it close to the hyoid bone, whilst *the deep part of the submaxillary gland* and *Wharton's duct* occupy an intermediate place. Although the *submaxillary ganglion* is very minute, its relations are so precise that it is very easily found. By seizing hold of the lingual nerve and dissecting carefully with the point of the knife in the interval between it and the deep part of the submaxillary gland, the ganglion will be exposed and its roots and branches of distribution made out. Upon the genio-hyo-glossus, in front of the hyo-glossus the dissector will note the *sublingual gland* with its artery of supply. Certain structures will also be seen passing under cover of the posterior margin of the hyo-glossus muscle; these are:—(1) the glosso-pharyngeal nerve immediately below the stylo-glossus muscle; (2) the stylo-hyoid ligament, a little lower down; and (3) the lingual artery, close to the hyoid bone.

The Hyo-glossus is a quadrate flat muscle which arises from the whole length of the greater cornu, and also from the body of the hyoid bone. Its fibres pass upwards to the posterior part of the side of the tongue where they ascend under cover of the stylo-glossus. The hyo-glossus is supplied by the hypoglossal nerve.

The Stylo-glossus is an elongated fleshy slip which takes origin from the anterior aspect of the styloid process near its tip. Passing downwards and forwards its fibres may be traced upon the side of the tongue as far as the tip. They decussate with the fasciculi of the preceding muscle. The nerve of supply to the stylo-glossus comes from the hypoglossal.

The Genio-hyoid (musculus geniohyoideus) is placed close to the mesial plane, in contact with its fellow of the opposite side. It is a short muscle which arises from the lower of the two genial tubercles upon the posterior surface of the symphysis of the mandible, and extends downwards and backwards to gain insertion into the fore aspect of the body of the hyoid bone. The hypoglossal gives the nerve of supply to the genio-hyoid.

Submaxillary Gland.—The submaxillary gland consists of a superficial and a deep portion, the *superficial* or *main part* has already been noted as the most conspicuous object in the digastric triangle. In size and shape it may be compared to a walnut, and it presents very definite relations. It is covered by skin, superficial fascia, platysma, and deep fascia, and lies under shelter of the body of the mandible—a distinct depression in the bone corresponding to its upper and outer surface. Behind, it is shut off from the parotid gland by the stylo-maxillary ligament, whilst in front, it is limited by the anterior belly of the digastric muscle. It rests upon the mylo-hyoid, and lodged in a deep groove in its substance is the facial artery. The *deep part* of the gland is a slender prolongation, which is tucked round the posterior margin of the mylo-hyoid. It lies between the mylo-hyoid and the hyo-glossus muscles.

Wharton's Duct.—The duct of the submaxillary gland is termed *Wharton's duct.* It emerges from the main part of the gland, and with the deep part of the gland it proceeds forwards upon the hyo-glossus muscle between the lingual nerve above and the hypoglossal nerve below. Reaching the surface of the genio-hyo-glossus muscle, it inclines slightly upwards and is crossed by the lingual nerve. Finally, it passes under cover of the sublingual gland, and gains the floor of the mouth. Here it opens by a small orifice placed on the summit of a papilla which lies close to the side of the frænum linguæ (Fig. 238).

The wall of Wharton's duct is much thinner than that of the parotid duct, and consequently, if a small opening be made in it, the dissector will experience little difficulty in passing a fine probe or bristle along it into the mouth.

Sublingual Gland.—The sublingual gland is the smallest of the three salivary glands. It has an elongated shape and in length it measures about one inch and a-half. Its relations are very definite. *Above*, it is related to the fore part of the floor of the mouth, being separated from the cavity

by the mucous membrane alone (Fig. 238, 19). *Internally* it rests upon the genio-hyo-glossus muscle, whilst *externally* it is lodged in a fossa on the deep aspect of the mandible,

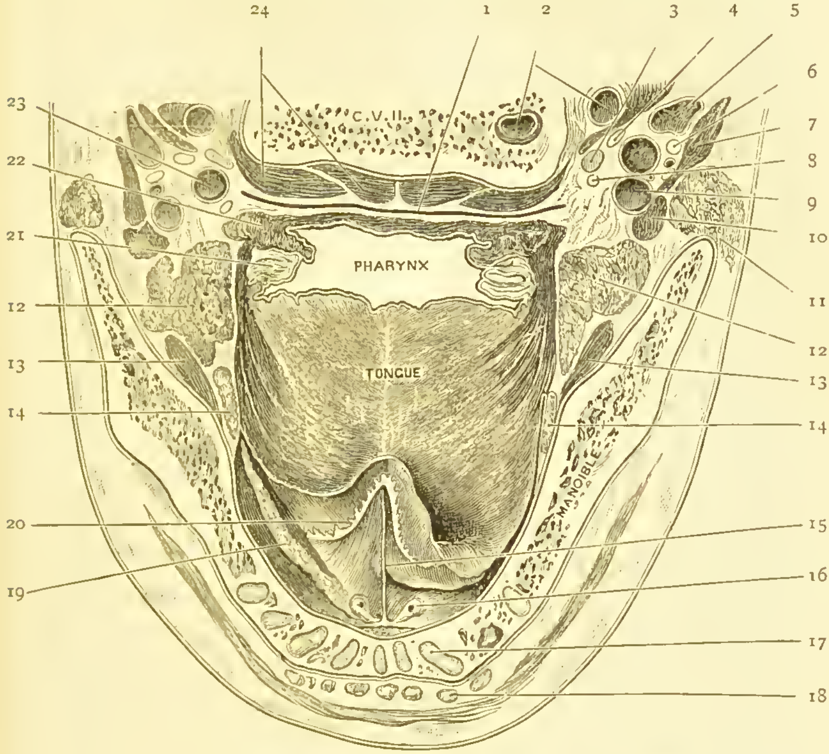

FIG. 238.—Transverse section through the mandible and neck. The tongue has been cut through horizontally. The tip of the lower part of the tongue is partially raised to show the sublingual region.

1. Retro-pharyngeal space.
2. Vertebral artery.
3. Superior cervical ganglion.
4. Vagus nerve.
5. Internal jugular vein.
6. Hypoglossal nerve.
7. Posterior belly of digastric.
8. Glosso-pharyngeal nerve.
9. External carotid.
10. Stylo-hyoid.
11. Parotid gland.
12. Submaxillary gland.
13. Mylo-hyoid.
14. Sublingual gland.
15. Frænum linguæ.
16. Opening of Wharton's duct.
17. Root of left lateral incisor.
18. Labial glands.
19. Elevation on the floor of the mouth corresponding to the sublingual gland.
20. Plica fimbriata.
21. Tonsil.
22. Stylo-pharyngeus.
23. Internal carotid.
24. Pervertebral muscles.

immediately external to the symphysis. *Below*, it is supported by the mylo-hyoid muscle. Its anterior extremity reaches the mesial plane above the anterior border of the genio-hyo-glossus and is in contact with its fellow of the opposite side. The duct of Wharton and the lingual nerve are prolonged forwards under cover of the sublingual gland.

Numerous small ducts (the number varying from eight to twenty) proceed from the sublingual gland. These are called the *ducts of Rivini*, and they have two modes of termination. Some open into Wharton's duct; others open directly into the mouth by piercing the mucous membrane which overlies the gland. One of the latter, larger than the others, receives the special name of the *duct of Bartholin*, and this opens into the mouth close to the orifice of the duct of Wharton.

Lingual Nerve.—In the dissection of the pterygo-maxillary region, the lingual nerve has been seen passing downwards between the ramus of the mandible and the internal pterygoid muscle. It now inclines forwards to reach the side of the tongue, and, passing over the superior constrictor muscle of the pharynx, it lies below the last molar tooth between the mucous membrane and the body of the mandible. At this point it is in danger of being hurt by the clumsy extraction of one of the lower molars, and here also it may be divided by the surgeon, from the inside of the mouth. In its further course the nerve keeps close to the side of the tongue, crossing the upper part of the hyo-glossus, and, beyond this, the duct of Wharton. It is placed immediately under the mucous membrane of the mouth, and it can be traced as far as the tip of the tongue.

The *branches* which proceed from the lingual nerve in this region are of two kinds—(1) twigs of communication; (2) branches of distribution.

Twigs of Communication.	1. Two or more to the submaxillary ganglion. 2. One or two which descend along the anterior border of the hyo-glossus muscle to unite with the hypoglossal nerve.

Branches of Distribution.
1. Slender filaments to the mucous membrane of the mouth and gums.
2. A few twigs to the sublingual gland.
3. Branches to the tongue.

The *lingual branches* pierce the substance of the tongue, and then incline upwards to supply the mucous membrane with the conical and fungiform papillæ over the anterior two-thirds of this organ.

Submaxillary Ganglion.—This is a minute ganglion which will be found lying upon the upper part of the hyo-glossus muscle in the interval between the lingual nerve and the deep part of the submaxillary gland, under cover of the mylo-hyoid muscle. In size it is not larger than the head of a large pin, and, when freed from the connective tissue surrounding both it and its branches, it will be seen to be suspended from the lingual nerve by two short branches, which enter its upper border, and are separated by a distinct interval. Of these, the posterior connecting twig is frequently in the form of two or three filaments, which convey to the ganglion its sensory and secretory roots, whilst the anterior connecting branch must be looked upon as a twig given by the ganglion to the lingual nerve.

In common with the other ganglia developed in connection with the branches of the fifth cranial nerve, this ganglion has three roots—viz. (1) a *sensory root* from the lingual nerve; (2) a *secretory root* from the chorda tympani; and (3) a *sympathetic root* from the plexus around the facial artery.

From its lower border several minute twigs proceed, and these are distributed—(1) to the submaxillary gland; (2) to Wharton's duct; and (3) to the mucous membrane of the mouth.

The Hypoglossal Nerve has been traced in the dissection of the anterior triangle to the point where it disappears under cover of the mylo-hyoid muscle (p. 229). It is now seen passing forwards upon the hyo-glossus muscle above the

hyoid bone, and below the level of the deep part of the submaxillary gland. At the anterior border of the hyo-glossus it gains the surface of the genio-hyo-glossus muscle, into the substance of which it sinks. Its further course is along the lower surface of the tongue, close to its fellow of the opposite side. Whilst the lingual nerve, therefore, clings to the side of the tongue, the hypoglossal is placed upon its under aspect, close to the mesial plane. Upon the hyo-glossus muscle it is accompanied by one of the lingual veins, frequently termed the *ranine vein.*

The *branches* which spring from the hypoglossal nerve in this region are very numerous, and are entirely distributed to muscles. It supplies—(1) the stylo-glossus; (2) the hyo-glossus; (3) the genio-hyo-glossus; (4) the genio-hyoid; and (5) the intrinsic muscles of the tongue.

In addition, it communicates freely with the lingual nerve. The more apparent of these connections take place in the form of one or more loops in relation to the anterior border of the hyo-glossus. Other communications with the same nerve are affected in the substance of the tongue.

Reflection of the Hyo-glossus.—The hyo-glossus should now be carefully detached from the hyoid bone, and thrown upwards towards the tongue. In doing this there is no need to divide the structures which lie upon its surface. By the reflection of this muscle the following structures will be fully displayed—(1) the second and third stage of the lingual artery, with its dorsalis linguæ branch and the veins which accompany it; (2) the posterior part of the genio-hyo-glossus; (3) the origin of the middle constrictor of the pharynx; and (4) the attachment of the stylo-hyoid ligament.

The Genio-hyo-glossus is a flat triangular muscle, the inner surface of which is in contact in the mesial plane with its fellow of the opposite side. It arises by a short pointed tendon from the upper of the two genial tubercles which project from the posterior aspect of the symphysis of the mandible, and from this its fleshy fasciculi spread out in a fan-shaped manner. By far the greater part of the muscle is inserted into the tongue by an insertion which extends

from the tip backwards throughout the whole length of the organ; below the tongue, a few fibres reach the side of the pharynx, whilst the remainder are inserted into the body of the hyoid bone. As we have already noted, the genio-hyo-glossus is supplied by twigs from the hypoglossal nerve.

Lingual Artery (arteria lingualis).—As the lingual artery is now fully exposed it can be conveniently studied at this stage. It springs from the fore part of the external carotid, and it is customary to describe it in three parts—viz. (1) a part extending from its origin to the posterior border of the hyo-glossus muscle; (2) a part lying in relation to the upper border of the hyoid bone; (3) a portion ascending under cover of the anterior border of the hyo-glossus muscle to the under surface of the tongue, where it ends in a terminal branch called the *ranine* artery (Fig. 237).

The *first part* has been fully examined in a previous dissection. It lies in the carotid triangle of the neck, and is therefore comparatively superficial. It is crossed by the hypoglossal nerve, the tendon of the digastric and the stylo-hyoid muscle. The *second part* proceeds forwards along the upper border of the great cornu of the hyoid bone, and is covered by the hyo-glossus muscle which intervenes between it and the hypoglossal nerve. The nerve, however, is placed at a slightly higher level. The deep or internal relations of the artery in this stage of its course are the middle constrictor of the pharynx and the genio-hyo-glossus. The *third part* ascends almost vertically upon the genio-hyo-glossus. It is overlapped by the anterior border of the hyo-glossus, and ends when it reaches the under surface of the tongue by turning forwards into its terminal or *ranine* branch.

The *branches* of the lingual artery are:—

1. Hyoid from the *first* part (p. 256).
2. Dorsalis linguæ from the *second* part.
3. Sublingual from the *third* part.
4. The ranine or terminal branch.

The *dorsalis linguæ* is generally represented by two or

more well-marked branches (rami dorsales linguæ) which pass upwards under cover of the hyo-glossus muscle to end in twigs to the mucous membrane covering the back part of the dorsum of the tongue. Some twigs are also supplied to the muscular substance of the organ, and a few may be traced backwards into the tonsil.

The *sublingual artery* (arteria sublingualis) emerges from under cover of the anterior border of the hyo-glossus, and then ascends upon the genio-hyo-glossus to reach the sublingual gland which it supplies. It also gives branches to the surrounding muscles and anastomoses with its fellow of the opposite side and with the submental branch of the facial artery.

The *ranine artery* runs forwards upon the inferior aspect of the tongue as far as the tip. It can easily be exposed by dividing the mucous membrane along its course, when it will be seen to lie close to the attachment of the frænum of the tongue, and to be continued forwards in the interval between the genio-hyo-glossus and the inferior lingualis muscle. Its course is tortuous to allow of the protrusion or elongation of the organ, and it gives off numerous branches.

Lingual Veins.—The lingual artery is accompanied by two small venæ comites which lie with it under cover of the hyo-glossus; but the main vein of the tongue, termed the *ranine*, accompanies the hypoglossal nerve upon the superficial surface of the hyo-glossus muscle. These veins receive tributaries corresponding more or less closely with the branches of the artery, and they open into the common facial vein, or perhaps directly into the internal jugular vein.

The Stylo-hyoid Ligament is the last structure to be examined in this dissection. It is a fibrous cord which springs from the tip of the styloid process and passes downwards and forwards to be attached under cover of the hyoglossus muscle to the lesser cornu of the hyoid bone. It is not uncommon to find it partially ossified; in other cases it may assume a ruddy hue and contain muscular fibres.

DEEP DISSECTION OF THE NECK.

In the deep dissection of the neck the following structures are displayed :—

1. The styloid process, with the three muscles which take origin from it.
2. The internal carotid artery.
3. The ascending pharyngeal artery.
4. The tonsillitic and ascending palatine branches of the facial artery.
5. The internal jugular vein.
6. Glosso-pharyngeal nerve.
7. Vagus nerve.
8. Spinal accessory nerve.
9. Hypoglossal nerve.
10. The cervical part of the sympathetic cord.
11. The first loop of the cervical plexus.
12. The rectus lateralis muscle.

Dissection.—Before the dissection is commenced, the skull-cap, which, up to the present time, has been retained in position by the flaps of scalp stitched over it, should be removed. The floor of the cranium should then be cleansed by sponging it with spirit and carbolic solution. To expose the styloid process and its muscles, it is necessary to turn aside the posterior belly of the digastric, and the external carotid artery. Detach the former from its origin, and throw it downwards and forwards towards the hyoid bone. Its nerve of supply from the facial must also be cut, and if the filament which connects this branch with the glosso-pharyngeal nerve has not been previously seen it should now be sought for. The external carotid artery may be divided immediately below the point where it divides into its two terminal branches. After cutting the occipital and posterior auricular arteries, it can be turned forwards out of the way.

Of the parts in connection with the styloid process, the stylo-hyoid and stylo-glossus muscles and the stylo-hyoid ligament have been already fully examined ; the stylo-pharyngeus muscle alone remains to be described. In cleaning the fibres of this muscle, be careful not to injure the glosso-pharyngeal nerve which appears at its lower border, and gives to it its nerve of supply.

The Stylo-pharyngeus is the longest of the three slender muscles which spring from the styloid process. It arises

from its deep or inner surface close to its root, and extends downwards and forwards to gain the side of the pharynx. Here it disappears under cover of the upper border of the middle constrictor muscle, and its fibres spread out, to be inserted for the most part into the upper and hinder borders of the thyroid cartilage; a certain proportion, however, are lost in the wall of the pharynx. The stylo-pharyngeus muscle is supplied by a branch from the glosso-pharyngeal nerve.

Dissection.—Snip through the base of the styloid process with the bone-pliers, and throw it and its attached muscles downwards and forwards. The *internal carotid* and *ascending pharyngeal arteries* may now be followed up to the base of the skull. The *glosso-pharyngeal*, *vagus*, *spinal accessory*, and *hypoglossal nerves*, and the *superior cervical ganglion*, with their various connections and branches, must at the same time be dissected. This is an exceedingly difficult dissection. A dense and tough fascia envelops these structures, and a great amount of patience is required to trace the branches of the nerves through it. One nerve—*the pharyngeal branch of the vagus*—which proceeds downwards and forwards upon the superficial or outer aspect of the internal carotid, is especially liable to injury, and must therefore be borne in mind from the very outset of the dissection. The *internal larnygeal* and the *external larnygeal nerves* have been previously displayed in the anterior triangle of the neck. These, if traced upwards, will lead to the *superior laryngeal branch* of the vagus, which is carried downwards upon the deep aspect of the internal carotid artery. At the base of the skull, all the nerve-trunks will be found making their appearance close together in the interval between the internal jugular vein and the internal carotid artery; whilst behind the vein, the *rectus lateralis muscle* and the *first loop* of the *cervical plexus* will be seen.

The Internal Carotid Artery (arteria carotis interna) is one of the two terminal branches of the common carotid, and commences at the level of the upper border of the thyroid cartilage. From this point it proceeds upwards in the neck in a vertical direction, until it reaches the base of the skull; here it disappears from view by entering the carotid canal of the petrous portion of the temporal bone, through which it reaches the interior of the cranium. The internal carotid artery can therefore be very appropriately

divided into three parts—viz. (1) a cervical; (2) a petrous; and (3) an intracranial. The cervical part alone comes under the notice of the student in the present dissection.

In the first instance, the internal carotid artery is placed within the carotid triangle, and is, therefore, comparatively superficial. It is covered by the integument, platysma, and fascia, and is overlapped by the sterno-mastoid muscle. As it proceeds upwards, it gradually sinks deeply, until it comes to lie under cover of the entire mass of the parotid gland, the styloid process, the stylo-pharyngeus muscle, the stylo-hyoid muscle, and the posterior belly of the digastric. *Three nerves* and *two arteries* will also be noticed to cross the vessel superficially, viz.:—

1. The hypoglossal nerve.	1. The occipital artery.
2. The glosso-pharyngeal nerve.	2. The posterior auricular artery.
3. The pharyngeal branch of the vagus nerve.	

The relationship of the external carotid artery to the internal carotid is a varying one. At first the external carotid lies in front of it, but soon, owing to its inclination backwards, it comes to lie directly superficial to the internal carotid. The following structures intervene between the two vessels :—

1. Styloid process.	4. Pharyngeal branch of vagus.
2. Stylo-pharyngeus muscle.	5. A portion of the parotid gland.
3. Glosso-pharyngeal nerve.	

Behind, the internal carotid rests upon the rectus capitis anticus major muscle, and is in contact with the vagus nerve and the superior cervical ganglion of the sympathetic. To its *outer side* is the internal jugular vein. A prolongation upwards of the carotid sheath encloses the two vessels together with the vagus nerve. On its *inner aspect* the internal carotid is related to the pharynx and the tonsil. At the same time it should be noted that the relationship to the tonsil is not so close as has generally been supposed. This may be seen in Fig. 223, p. 267, which represents a section

through the frozen head at the level of the upper part of the tonsil.

Before leaving this vessel, note that at the base of the skull four nerves appear in the interval between it and the internal jugular vein; these are the glosso-pharyngeal, the vagus, the spinal accessory, and the hypoglossal.

Ascending Pharyngeal Artery.—The origin of this vessel from the external carotid has already been observed (p. 259). It proceeds vertically upwards to the base of the skull, where it ends by dividing into minute meningeal twigs. Its relations are very simple. It is placed between the internal carotid artery and the wall of the pharynx, and this position it holds throughout its entire course.

The following branches will be recognised as springing from the ascending pharyngeal:—

1. Pharyngeal.
2. Prevertebral.
3. Meningeal.

The *pharyngeal branches* (rami pharyngei) supply the pharynx, and the lower members of the series anastomose with the superior thyroid artery. Higher up, a larger *palatine branch* distributes twigs to the Eustachian tube, the soft palate, and the tonsil.

The *prevertebral branches* are small twigs which are given to the prevertebral muscles, and anastomose with the ascending cervical artery.

The *meningeal twigs* enter the cranium through three openings, viz., the foramen lacerum medium, the jugular foramen, and the anterior condyloid foramen.

Inferior Palatine and Tonsillitic Arteries.—At this stage the dissector should again examine these vessels—the first branches which are given off by the facial artery. They have already been described (p. 257), but their relations as they ascend in the neck can now be more satisfactorily studied. The size of the *inferior palatine* is very variable,

and depends very much upon that of the palatine branch of the *ascending pharyngeal.*

Internal Jugular Vein (vena jugularis interna).—The internal jugular vein is the largest venous channel of the neck. It is directly continuous with the lateral sinus of the cranial cavity, and it enters the neck through the posterior compartment of the jugular foramen. From this it proceeds downwards, until it reaches the posterior aspect of the inner end of the clavicle, where it joins the subclavian vein to form the innominate or brachio-cephalic vein. Its commencement in the jugular foramen shows a slight dilatation, termed *the bulb*, the lumen of which remains at all times patent owing to the connection of its walls to the margins of the foramen. By passing a probe from the lateral sinus into the internal jugular vein the continuity of the two channels can be easily demonstrated.

The relations which the internal jugular vein presents in the neck can be summed up in a very few words. At the base of the skull it lies behind the internal carotid artery, and rests upon the rectus lateralis muscle. Very soon, however, it changes its relationship to the internal carotid, and comes to lie upon its outer side. This position it maintains until it reaches the upper border of the thyroid cartilage. Below this level it is continued downwards upon the outer side of the common carotid artery.

Throughout its whole length it is included within a sheath of fascia common to it, the two arteries along which it lies and the vagus nerve. Lastly, at the root of the neck, its terminal part crosses the first portion of the subclavian artery.

But there are some slight differences to be noted between the two veins of opposite sides. The *right vein* is usually considerably the larger of the two, and as they approach the root of the neck they both incline slightly to the right. From this it follows that the *left vein* is closely applied to the lower portion of the common carotid artery of that side,

whilst the *right vein* is separated from its companion artery by a narrow interval which presents a triangular figure. The base of this triangle is formed by the first part of the subclavian artery and it is bisected by the vagus nerve.

The tributaries which join the internal jugular vein have for the most part been previously studied. They are :—

1. Inferior petrosal sinus (p. 132).
2. Pharyngeal veins.
3. Lingual veins (p. 332).
4. Common facial vein (p. 258).
5. Superior thyroid vein (p. 256).
6. Middle thyroid vein (p. 261).
7. Thoracic duct on the left side and the right lymphatic duct on the right side (p. 242).

The *inferior petrosal sinus* leaves the cranial cavity by the anterior compartment of the jugular foramen, and joins the fore part of the internal jugular vein close to the base of the skull. By passing a probe from the interior of the skull through the sinus its connection with the vein can readily be made out.

The *pharyngeal tributaries* join the internal jugular about the level of the hyoid bone. They come from a venous plexus which lies upon the side of the pharynx, and presents free communications above with the pterygoid plexus.

Dissection.—The internal jugular vein should now be slit open. A short distance above its termination a single or a double flapped valve will be discovered. The vein should then be divided about two inches below its commencement and its upper part thrown upwards. This is done to enable the dissector to obtain a better view of the hypoglossal nerve as it issues from the anterior condyloid foramen.

The Glosso-pharyngeal, the Vagus or Pneumogastric, and the Spinal Accessory Nerves.—These nerves have, on a previous occasion, been seen leaving the cranial cavity through the middle compartment of the jugular fossa, in the interval between the commencement of the internal jugular vein behind and the inferior petrosal sinus in front (p. 127 and Fig. 194, p. 131). It is well that the dissector should again examine the interior of the cranial cavity and refresh his memory as to the manner in which they enter the

foramen. The *glosso-pharyngeal* occupies the foremost position, and it is cut off from the others by possessing a special and separate tube-like sheath of dura mater. The *spinal accessory* is placed behind the *vagus*, and both are included within the same sheath of dura mater. They therefore traverse the foramen in close contact with each other. Reaching the exterior of the skull, the three nerves at first lie together with the hypoglossal nerve in the interval between the internal jugular vein and the internal carotid artery, but soon they choose different routes. The *spinal*

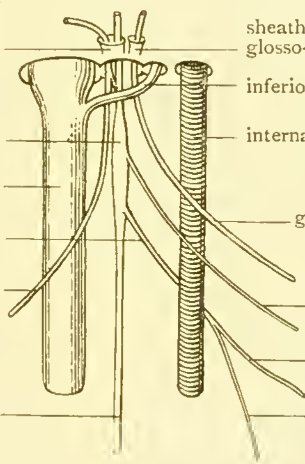

FIG. 239.—Diagram of the relation of parts in the jugular foramen.

accessory inclines backwards over or behind the internal jugular vein; the *glosso-pharyngeal* inclines forwards over the internal carotid; whilst the *vagus* proceeds vertically downwards between these vessels (Fig. 239).

In an ordinary dissection it is impossible to follow out many of the minute twigs which take origin from these nerves in the region of the basis cranii. To do so it is necessary to possess a perfectly fresh part, which has been specially prepared by having the soft parts toughened with spirit and the bone softened by immersion in a weak solution of acid. Even then the dissection is a difficult one, although it should

certainly be undertaken by the advanced student in the event of his being able to obtain a part for the purpose.

In the following description of these nerves the account of the branches which can in all cases be traced is printed in *large type*, whilst that of those requiring special dissection is printed in *small type*.

Glosso-pharyngeal Nerve.—The glosso-pharyngeal nerve inclines downwards and forwards and crosses the internal carotid artery superficially. It passes under cover of the styloid process and the stylo-pharyngeus muscle, and at the lower border of the latter it hooks round the muscle and then curves forwards upon its superficial surface to gain the base of the tongue. In the dissection of the submaxillary region, its terminal part has been seen disappearing under cover of the posterior border of the hyo-glossus muscle; here it ends in *lingual branches*.

In the present dissection the following branches should be made out:—

1. Communicating branch from the facial.
2. Nerve to the stylo-pharyngeus.
3. Pharyngeal.
4. Tonsillitic.
5. Lingual.

The *communicating branch from the facial* is a small but important twig. It springs from the nerve to the posterior belly of the digastric, and, as a rule, emerges from midst the fibres of this muscle to join the glosso-pharyngeal close to the lower part of the jugular foramen. This branch is considered to convey to the glosso-pharyngeal the motor fibres which it supplies to the stylo-pharyngeus muscle.

The *stylo-pharyngeal nerve* is a small twig which enters the muscle of the same name. The greater part of its fibres, however, are continued through the muscle to the mucous membrane of the pharynx.

The *pharyngeal branches* consist—(1) of one or two small twigs which perforate the superior constrictor to reach the mucous membrane of the pharynx; and (2) a larger nerve

which comes off higher up and joins the pharyngeal branch of the vagus to form the pharyngeal plexus. It frequently divides into two or more branches.

The *tonsillitic branches* proceed from the glosso-pharyngeal near the base of the tongue. They form a plexus over the tonsil, termed the *circulus tonsillaris*, and give twigs to the mucous membrane of the isthmus faucium and the soft palate.

The *terminal* or *lingual branches* will be followed in the dissection of the tongue.

There are still other points in connection with the glosso-pharyngeal nerve which require mention. At the lower part of the jugular foramen two minute ganglia are formed upon its trunk, and from the lower of these certain minute branches are given off. The upper ganglion is called the *jugular ganglion;* the lower one is termed the *petrous ganglion.*

The *jugular ganglion* is a minute ganglionic swelling, which only involves a portion of the fibres of the nerve-trunk, and is placed in the upper part of the bony groove in which the nerve lies as it proceeds through the jugular foramen.

The *petrous ganglion* is a larger swelling, which involves the entire nerve-trunk, and lies at the opening of the jugular foramen between the inferior petrosal sinus (which intervenes between it and the anterior border of the foramen) and the vagus nerve invested by its fibrous sheath derived from the dura mater. Its length is not more than two or three lines. Three branches of communication enter or proceed from it. These connect it with—(1) the superior cervical sympathetic ganglion; (2) the auricular branch of the vagus; and (3) the root-ganglion of the vagus.

In addition to these twigs the *tympanic nerve* or the *nerve of Jacobson* takes origin from the petrous ganglion.

Tympanic Nerve.—The ultimate destination of this nerve may be regarded as being the otic ganglion, but it takes a very circuitous route to gain this structure. It enters a minute foramen on the ridge which separates the jugular fossa from the carotid foramen on the under surface of the petrous bone, and it is conducted by a narrow canal to the tympanic cavity. It traverses the inner wall of this chamber, grooving the promontory. Having gained the anterior part of the tympanum, it enters the bone a second time, and runs in a minute canal, which tunnels the petrous bone below the upper end of the channel in which is lodged the tensor tympani muscle. In this part of its course the tympanic

nerve is joined by a branch from the geniculate ganglion of the facial nerve, and, after the junction is effected, it is termed the *small superficial petrosal nerve.*

The canal in which the *small superficial petrosal nerve* is lodged opens into the cranial cavity upon the anterior face of the petrous bone. immediately external to the hiatus Fallopii. Through this the nerve emerges, and soon leaves the interior of the cranium by passing downwards in the interval between the great wing of the sphenoid and the petrous bone. Outside the skull it ends by joining the otic ganglion.

In the tympanic cavity the *tympanic nerve* gives branches of supply—

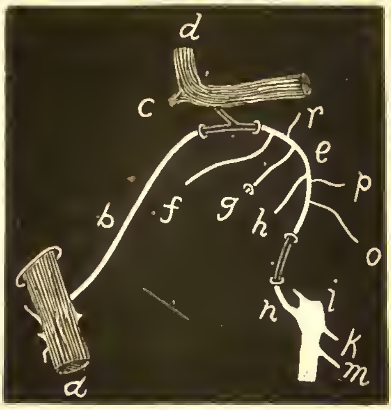

FIG. 240.—Diagram of the tympanic nerve. (Modified from HENLE.)

a. Inferior maxillary division of trigeminal nerve.
b. Small superficial petrosal nerve.
c. Great superficial petrosal nerve.
d. Facial nerve.
e. Tympanic nerve in the tympanic cavity.
f. Branch to Eustachian tube.
g. Small deep petrosal nerve.
h. Carotico-tympanic nerve.
k. Communicating twig to vagus.
l. Petrous ganglion of the glossopharyngeal.
m. Communicating twig to facial nerve.
n. Tympanic nerve before it enters the petrous bone.
o and *p* branches to the mastoid cells.
r. Branch to tympanic plexus.

(1) to the mucous membrane of the tympanum; (2) to the lining membrane of the mastoid cells (Fig. 240, *p*, *o*); and (3) to the mucous membrane of the Eustachian tube (Fig. 240, *f*). It also gives off a fine branch termed the *small deep superficial petrosal nerve* (n. petrosus profundus minor). This enters a canal in the processus cochleariformis which conducts it to the foramen lacerum medium, where it effects a junction with the carotid plexus. The tympanic nerve likewise receives a minute twig from the carotid plexus which is called the *nervus caroticotympanicus.*

Vagus or Pneumogastric Nerve.—The vagus passes through the middle compartment of the jugular foramen in company with the spinal accessory—both being included within the same sheath of dura mater. In the neck it pursues a vertical course, lying, in the first instance, between the internal jugular vein and the internal carotid artery, and afterwards between the same vein and the common carotid artery. Further, as has been already observed, it is inclosed within the sheath which envelops these vessels, and it lies upon a plane posterior to them. At the root of the neck it enters the thorax, and shows different relations on the two sides. On the *right* side it crosses the first part of the subclavian artery; on the *left* side it proceeds downwards between the common carotid and left subclavian arteries, and passes under cover of the left innominate vein.

As in the case of the glosso-pharyngeal, the vagus shows two ganglia in connection with its upper part. These are the *ganglion of the root* (*ganglion superius*) and the *ganglion of the trunk* (*ganglion inferius* or *plexus nodosus*).

The Ganglion of the Root is situated within the jugular foramen. It is a rounded swelling which is connected by communicating twigs with several of the nerves in the neighbourhood, and which gives off two branches of distribution.

Branches of Communication.	Branches of Distribution.
1. With the petrous ganglion of the glosso-pharyngeal. 2. With the spinal accessory. 3. With the superior ganglion of the sympathetic.	1. Recurrent nerve. 2. Auricular nerve.

The *recurrent branch* is a minute twig which runs backwards through the jugular foramen, and, dividing into two branches, is distributed to the dura mater in the posterior cranial fossa.

The *auricular nerve* (Arnold's nerve) obtains a filament of communication from the petrous ganglion of the glosso-pharyngeal, and proceeds

backwards upon the outer surface of the bulb of the internal jugular vein to enter a minute aperture on the posterior part of the outer wall of the jugular foramen. A narrow canal now conducts it through the substance of the temporal bone, and, on its way, it crosses internal to the Fallopian canal a short distance above the stylo-mastoid foramen. It is thus brought into close relation with the facial nerve, and is connected with it by an ascending and a descending branch of communication. Finally, it appears on the surface of the skull in the interval between the mastoid process and the external auditory meatus. Its further course is described on p. 283.

Ganglion of the Trunk.—After emerging from the jugular foramen, the vagus nerve is joined by the *accessory portion* of the *spinal accessory nerve*, and swells out into the ganglion of the trunk.

The *ganglion of the trunk* is an elongated reddish-coloured swelling of about three-quarters of an inch in length, which is developed upon the stem of the vagus nerve half-an-inch below the base of the cranium. Strong branches of communication pass between this ganglion, the first loop of the cervical plexus, and the superior cervical ganglion of the sympathetic. Further, the hypoglossal nerve is generally closely bound to it by fibrous attachment, in the midst of which some interchange of nerve filaments takes place.

The Branches of Distribution which arise from the vagus nerve in the neck may now be studied. These are:—

1. Pharyngeal.
2. Superior laryngeal.
3. Inferior or recurrent laryngeal.
4. Cardiac.

The Pharyngeal Branch springs from the upper part of the ganglion of the trunk, and runs downwards and forwards, superficial to the internal carotid artery, to end in the *pharyngeal plexus*. Very frequently it is replaced by two branches, of which the upper is the larger.

The Superior Laryngeal Nerve is a much larger branch, which takes origin from the middle of the same ganglion. It passes downwards and forwards, but differs from the pre-

ceding nerve by passing *under cover of* the internal carotid artery. In this situation it ends by dividing into the *internal laryngeal* and *external laryngeal nerves;* both of these have been previously seen in the dissection of the anterior triangle (pp. 215 and 219). Before it divides, the superior laryngeal effects communications by means of fine twigs with the superior cervical ganglion of the sympathetic, and it also receives one or two filaments from the pharyngeal plexus.

The *internal laryngeal nerve* runs forwards to the interval between the hyoid bone and the thyroid cartilage, and, disappearing under cover of the posterior border of the thyro-hyoid muscle, it pierces the membrane of the same name, and enters the larynx.

The *external laryngeal nerve* is a very slender branch, which inclines downwards and forwards to reach the crico-thyroid muscle in which it ends. It supplies a few filaments to the inferior constrictor of the pharynx and a fine twig to the cardiac plexus, whilst it receives a communicating branch from the superior cervical ganglion of the sympathetic.

The Recurrent Laryngeal Nerve arises differently on the two sides. On the right side, it springs from the vagus as it crosses the first part of the subclavian artery, and it adopts its recurrent course by hooking round this vessel. On the left side, it arises in the thorax, and hooks round the aortic arch (or, more correctly speaking, around the termination of the obliterated ductus arteriosus). In the neck each nerve ascends in the groove between the trachea and œsophagus, and passing behind or in front of the inferior thyroid artery, or it may be between the two terminal branches of this artery, it disappears under cover of the lower border of the inferior constrictor muscle, to enter the larynx.

Before the recurrent laryngeal nerve reaches the larynx it gives off several branches—viz. (1) cardiac branches; (2) twigs to the trachea and œsophagus; and (3) a few filaments to the inferior constrictor as it passes under cover of its lower margin.

The Cardiac Branches which the pneumogastric gives off in the neck are long slender filaments, which vary in number from two to three or even more. They run downwards along the common carotid artery, and, with the exception of the lowest branch on the left side, they enter the deep cardiac plexus.

The *lowest cardiac branch* of the left pneumogastric enters the thorax, and terminates in the superficial cardiac plexus.

Spinal Accessory Nerve.—This nerve consists of two parts—an *accessory* and a *spinal.* In the foramen jugulare the *accessory portion* is connected by one or two fine twigs with the root-ganglion of the vagus, and below the basis cranii it leaves the spinal part and joins the vagus.

The accessory part of the spinal accessory nerve contributes to the vagus the greater proportion of its motor fibres. They pass over the surface of the trunk-ganglion, and are continued into the pharyngeal, and perhaps also into the superior laryngeal nerves. Some of the fibres are likewise carried down the stem of the vagus into the recurrent laryngeal nerve.

The *spinal part* of the spinal accessory is directed backwards under the transverse process of the atlas. It crosses the internal jugular vein, and disappears into the substance of the sterno-mastoid muscle. Its further course has been already studied (pp. 141 and 219). It is distributed to two muscles—viz., the sterno-mastoid and the trapezius.

Pharyngeal Plexus.—This is a meshwork of fine nerve filaments, which is formed upon the lateral wall of the pharynx at the level of the middle constrictor muscle. The pharyngeal branches of the vagus, glosso-pharyngeal, and superior cervical ganglion of the sympathetic enter into its construction, and one or more minute ganglia are developed in connection with it. Its terminal twigs are given to the muscles and mucous membrane of the pharynx, and one branch (the *ramus lingualis vagi*) connects the plexus with the hypoglossal nerve.

The Hypoglossal Nerve makes its exit from the cranium, through the anterior condyloid foramen. It pierces the dura

mater in two separate parts, which unite into one stem at the entrance of the bony foramen. As it issues from the anterior condyloid foramen it lies deeply under cover of the internal jugular vein and the internal carotid artery, but it almost immediately inclines outwards, and, taking a half spiral turn around the trunk-ganglion of the vagus, it appears between the two vessels, and is continued downwards and forwards. Its close connection with the ganglion of the trunk of the vagus has already been noted. The two nerves at this point are almost inseparably united by dense connective tissue, and in the midst of this an interchange of nerve fibres takes place. Gaining the lower border of the posterior belly of the digastric muscle, the hypoglossal nerve hooks round the occipital artery, and enters the anterior triangle of the neck. From this point to the under surface of the tongue it has already been traced.

Branches of communication.—Near the base of the skull the hypoglossal is brought into connection with (1) the superior cervical ganglion; (2) the vagus; and (3) the first cervical nerve. Further, as it turns round the occipital artery it receives the *ramus lingualis vagi* from the pharyngeal plexus.

The importance of the connection between the hypoglossal and the first cervical nerve has already been alluded to (p. 245 *v.* Fig. 218).

Branches of distribution.—With the exception of the minute recurrent and vascular twigs, which come off within the condyloid foramen, the branches of distribution which proceed from the hypoglossal nerve have been described (pp. 230 and 330).

The *recurrent branch* arises in the upper part of the anterior condyloid foramen, and, regaining the interior of the cranium, it is distributed to the dura mater around the foramen magnum.

The *vascular twigs* are some fine filaments, which are said to be supplied to the deep aspect of the internal jugular vein.

Dissection.—In the dissection of the neck the greater part of the cervical sympathetic, with the branches which proceed from it, has been

displayed. The inferior ganglion, which lies deeply in the hollow between the transverse process of the seventh cervical vertebra and the neck of the first rib, is still to a certain extent concealed, and must now be displayed. Dislodge the subclavian artery from its place on the first rib behind the scalenus anticus muscle, and turn it well inwards. To do this efficiently, it will be necessary to cut the superior intercostal artery at its origin; this vessel runs downwards upon the outer side of the sympathetic. Great care must be taken to preserve uninjured the fine nerves which proceed downwards in front of the first part of the subclavian artery. If more space for the dissection is required, the fore part of the first rib may be removed by the bone-pliers, but, as a general rule, this will not be found to be necessary.

Sympathetic Cord in the Neck.—The number of ganglia which are developed upon the sympathetic cord in the neck is reduced to *three;* but inasmuch as the superior cervical ganglion is brought into connection with the four upper cervical nerves, there is good reason to suppose that it is formed by the coalescence of four ganglia. Upon similar grounds, we may argue that the middle and inferior cervical ganglia are each formed by the amalgamation of two primitive ganglia.

The sympathetic cord takes a vertical course through the neck in front of the roots of the transverse processes of the vertebræ. It lies upon the rectus capitis anticus major and the longus colli muscles, and is embedded in the posterior wall of the carotid sheath. *Above*, it is prolonged upwards in the form of a stout, ascending nerve-trunk, which accompanies the internal carotid artery into the carotid canal; *below*, it becomes continuous over the neck of the first rib and behind the subclavian artery with the thoracic portion of the sympathetic. The branches take origin from the ganglia; occasionally, however, one or more may be observed to arise from the connecting cords.

The Superior Cervical Ganglion is the largest of the three ganglia. It is an elongated fusiform body which varies somewhat in size. It is placed upon the upper part of the rectus capitis anticus major, opposite the second and third vertebræ, and behind the internal carotid artery.

From its upper end the stout branch proceeds which enters the carotid canal, whilst its lower end tapers into the downward continuation of the cord. Numerous branches issue from it; of these some connect it with neighbouring nerves, whilst others are distributed in various ways.

The connecting branches are:—(1) slender filaments which connect it with the upper four cervical nerves; (2) twigs to both ganglia of the vagus; (3) to the petrous ganglion of the glosso-pharyngeal; and (4) to the hypoglossal. It is not connected with the spinal accessory.

The branches of distribution are:—

1. Rami vasculares.
2. Pharyngeal.
3. Superior cardiac.

The *rami vasculares* are soft delicate filaments which run towards the external carotid artery, and form a loose interlacement around it and its branches. From this plexus a branch is given to the intercarotid body; further, the part continued upon the facial artery supplies, as we have already noted, the sympathetic root to the submaxillary ganglion, whilst the subdivision upon the middle meningeal artery furnishes the corresponding root to the otic ganglion, as well as the *external superficial petrosal nerve* which runs to the geniculate ganglion of the facial nerve.

The *pharyngeal branches* course inwards between the two carotid arteries to join the pharyngeal plexus.

The *superior cardiac nerve* is a long slender branch which springs by several roots from the ganglion and then proceeds downwards behind the carotid artery. At different stages of its course it is joined by other branches of the sympathetic, by a branch from the vagus, and also by filaments from the external laryngeal and recurrent laryngeal nerves. The *right superior cardiac nerve* is continued into the thorax by passing behind or in front of the subclavian artery, and it ends in the deep cardiac plexus. The *left superior cardiac nerve* follows the left common carotid artery

in the thorax, and, crossing the arch of the aorta, ends in the superficial cardiac plexus.

The Middle Cervical Ganglion is the smallest of the three ganglia of the neck. It is placed opposite the sixth cervical vertebra in close proximity to the inferior thyroid artery, upon which, indeed, it not unfrequently rests. It presents the following branches :—

1. Twigs which connect it with the *fifth* and *sixth spinal nerves*, and which pass between the contiguous margins of the scalenus anticus and longus colli muscles.
2. Thyroid branches which run to the thyroid body along the inferior thyroid artery, and which form connections with the external and recurrent laryngeal nerves.
3. The middle cardiac nerve.

On both sides *the middle cardiac nerve* enters the thorax and is lost in the deep cardiac plexus. In the neck it is connected with the superior cardiac nerve, and with the recurrent laryngeal nerve. On the *right* side it passes behind or in front of the subclavian artery ; on the *left* side it is continued downwards between the common carotid and subclavian arteries.

The Inferior Cervical Ganglion is lodged in the interval between the transverse process of the seventh cervical vertebra and the neck of the first rib. In this position it lies behind the vertebral artery. It is by no means uncommon to find it more or less completely fused over the neck of the first rib with the first thoracic ganglion. Again, the connection between it and the middle ganglion is generally in the form of two or more slender nerve-cords, of which one passes in front of the subclavian artery. The loop which is thus formed is termed the *ansa Vieussienii.*

The branches of the inferior cervical ganglion are :—

1. Connecting twigs with the seventh and eighth cervical nerves.
2. Rami vasculares.
3. Inferior cardiac nerve.

The *rami vasculares* are fine branches which form a plexus around the subclavian artery and its branches.

Others, remarkable for their large size, join the vertebral artery.

The *lower cardiac nerve* on both sides enters the deep cardiac plexus.

Dissection.—The little muscle termed the rectus capitis lateralis should now be cleaned, and its attachments defined. It lies in the interval between the transverse process of the atlas and the occiput, behind the commencement of the internal jugular vein. The anterior division of the first cervical nerve will be seen emerging from under cover of its inner margin.

Rectus Capitis Lateralis.—The rectus lateralis arises from the fore part of the upper surface of the extremity of the transverse process of the atlas, and is inserted into the under surface of the jugular eminence of the occipital bone. It is supplied by a branch from the anterior division of the first cervical nerve.

First Loop of the Cervical Plexus.—The anterior primary division of the first cervical or suboccipital nerve may next be examined. It will be noticed emerging from under cover of the inner surface of the rectus lateralis muscle. It at once turns downwards in front of the transverse process of the atlas, and, joining the ascending branch of the second cervical nerve, forms the first loop of the cervical plexus. From this loop branches are given to two muscles—viz., the rectus capitis anticus major and minor. It is likewise brought into connection by means of communicating twigs with—(1) the superior cervical ganglion; (2) the vagus; (3) the hypoglossal.

If the rectus lateralis muscle be detached from the transverse process of the atlas and turned upwards, a twig from the anterior division of the first cervical nerve will be found entering its deep surface; further, by cutting through the origin of the superior oblique muscle of the head, this nerve-division may be traced to the upper surface of the neural arch of the atlas, where it takes origin from the first spinal nerve-trunk (suboccipital nerve).

The entire length of the anterior primary division of the first cervical nerve may now be studied. It turns round

the superior articular process of the atlas, under cover of the vertebral artery and the rectus capitis lateralis, and, gaining the anterior aspect of the atlas, it enters into the formation of the first loop of the cervical plexus. As it lies in relation to the vertebral artery, it is joined by a filament from the sympathetic plexus which surrounds that vessel.

Removal of the Head and Neck from the Trunk.—By the time that the dissectors of the head and neck have arrived at this stage of their work, the dissectors of the thorax have in all probability finished their dissection. If this be the case, the head and neck may be removed from the trunk by cutting through the vertebral column at the level of the intervertebral disc between the third and fourth dorsal vertebræ. By this proceeding the three upper dorsal vertebræ, with the attached portions of the first, second, and third pairs of ribs, are removed with the neck. The scalene muscles and the longus colli are therefore preserved intact.

THE LATERAL PART OF THE MIDDLE CRANIAL FOSSA.

The structures contained within the middle cranial fossa may now be examined, and, in carrying out this dissection, the head should be supported on a block so that the floor of the cranial cavity looks upwards. The following are the structures which must be displayed:—

1. Cavernous venous sinus.
2. Internal carotid artery.
3. Middle meningeal artery.
4. Small meningeal artery.
5. The two roots of the trigeminal nerve, with the Gasserian ganglion and the three main divisions of the trigeminal nerve.
6. Oculomotor nerve (3rd cranial).
7. Trochlear nerve (4th cranial).
8. Abducent nerve (6th cranial).
9. Cavernous plexus of the sympathetic.
10. Great superficial petrosal nerve.
11. Small superficial petrosal nerve.

Dissection.—To expose these structures, the dura mater must be stripped from the inner part of the lateral portion of the middle cranial fossa. Enter the knife at the anterior clinoid process, and carry it backwards to the apex of the petrous bone. This incision must go no deeper than is necessary to divide the dura mater, and must be made immediately to the outer side of the openings in the membrane through which the oculomotor, the trochlear, and trigeminal nerves pass. It is very important to preserve these apertures intact, so that the proximal ends of these nerves may be held in position during the dissection. The incision through the dura mater may now be carried along the upper border of the petrous bone in the line of the superior petrosal sinus, and also outwards along the posterior margin of the lesser wing of the sphenoid. The dura mater may now be raised, and the greatest care must be taken in doing so, because it is intimately connected with the nerves which lie subjacent to it. Thus, where it forms the outer wall of the cavernous sinus, it is closely applied to the oculomotor and trochlear nerves, and firmly attached to the ophthalmic division of the trigeminal nerve, whilst over the petrous bone it is united to the surface of the Gasserian ganglion. The edge of the knife, therefore, must be kept close to the membrane, and a small portion of it may be left upon the nerves. This can afterwards be removed as the nerves are defined.

Cavernous Sinus—(Fig. 194 (*Sc*), p. 131).—The cavernous sinus has been opened by the above dissection. It is a short, wide venous channel, which extends upon the side of the body of the sphenoid bone, from the lower and inner end of the sphenoidal fissure backwards to the apex of the petrous portion of the temporal bone. In front, blood is conducted into it by the ophthalmic veins and the sphenoparietal venous sinus, whilst behind, the blood is drained away by the superior and inferior petrosal venous sinuses. But it has still other connections; thus, it receives some of the inferior cerebral veins, and internally it is brought into communication with the corresponding sinus of the opposite side by means of the anterior and posterior intercavernous sinuses (p. 132). Lastly, one or more emissary veins leave its under aspect, and, passing out of the cranium by the foramen ovale,[1] connect it with the pterygoid venous plexus.

[1] Or it may be through the foramen Vesalii when such exists in the sphenoid bone.

The cavernous sinus is formed in the same manner as the other venous sinuses. The two layers of the dura mater are separated from each other, and the interval is lined by a delicate membrane. A complicated network of interlacing trabeculæ occupies the lumen of the channel, and it is on this account that the term "cavernous" is applied to it. But, as we have already indicated, this sinus has an unusual importance to the anatomist, on account of its being traversed by the internal carotid artery, the cavernous plexus, and the oculomotor, trochlear, and abducent nerves, with the ophthalmic division of the trigeminal nerve. The precise relation which these structures bear to its walls will

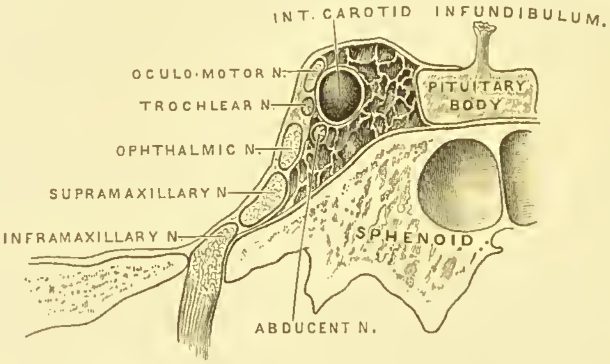

FIG. 241.—Section through the cavernous sinus. (After MERKEL, somewhat modified).

be described later on; in the meantime, it is only necessary to state that, two, viz., the internal carotid artery and the abducent nerve, are contained in the interval between the two layers of the dura mater. These are shut out from the blood-channel by the delicate lining membrane of the sinus. The oculomotor and trochlear nerves, with the ophthalmic division of the trigeminal nerve, are embedded in the outer wall of the sinus.

The Trigeminal or Fifth Cranial Nerve.—The two roots of this nerve have already been seen piercing the dura mater at the apex of the petrous portion of the temporal bone

under the anterior extremity of the tentorium. Now that the dura mater has been raised from the lateral part of the middle cranial fossa, the further relations of these nerve-roots within the cranium may be studied. It will be noticed that the loosely connected and parallel funiculi of the large *sensory root* at once begin to divide and join with each other so as to form a dense plexiform arrangement, whilst, at the same time, the nerve-root increases somewhat in breadth. The interlacement thus brought about occupies the smooth depression which marks the anterior aspect of the apex of the petrous portion of the temporal bone, and it sinks into the Gasserian ganglion.

The *Gasserian ganglion* is somewhat crescentic in form, and lies upon the sutural junction between the apex of the petrous bone and the great wing of the sphenoid bone. Here it is enclosed within a recess or space formed by a separation of the two layers of the dura mater, and called the *cavum Meckelii.* The concavity of the ganglion is directed inwards, and it is upon this aspect that it receives the interlacing fibres of the sensory root of the trigeminal nerve; the convexity of the ganglion is directed outwards, and from it emerge the three main divisions of the trigeminal nerve. These are, from before backwards—(1) the first, or ophthalmic division; (2) the second, or superior maxillary division; and (3) the third, or inferior maxillary division. The outer surface of the Gasserian ganglion has already been observed to be closely attached to the deep surface of the supporting or inner layer of the dura mater. By its inner part it is connected with the sympathetic by some fine filaments which come from the carotid plexus.

The *motor root* of the fifth nerve should now be followed. Before the nerve pierces the dura mater the motor root lies along the inner side of the large sensory root, but it soon changes its position and comes to lie upon the under surface of the sensory part. To display this relationship, draw the cut ends of the two roots through the aperture

in the dura mater which leads into the cavum Meckelii, and, gently dislodging the Gasserian ganglion from its place, turn it forwards and outwards so as to expose its deep surface. The small firm motor root can readily be recognised lying in a groove upon the deep surface of the ganglion, and if it be raised from this, it will be seen to have no connection with the ganglion, but to be continued onwards towards the foramen ovale. It ultimately joins the inferior maxillary division of the trigeminal nerve. This junction may take place within the cranium, in the foramen ovale, or immediately after it gains the exterior of the skull.

The three principal divisions of the trigeminal nerve may next be examined. Begin with the *inferior maxillary division*, which is the largest. This proceeds directly downwards, and almost immediately leaves the cranial cavity through the foramen ovale.

In isolating this large nerve trunk and defining the bony aperture through which it makes its exit, look carefully for the small meningeal artery which enters the cranium through the same foramen. If the injection has been forced into this vessel it can easily be detected. Through the foramen ovale the minute emissary veins which connect the cavernous sinus with the pterygoid venous plexus also pass

The *superior maxillary division*, which is composed entirely of sensory fibres, is prolonged forwards, and, after a short course within the cranium, makes its exit through the foramen rotundum. Near its origin it gives off a fine *recurrent branch* to the dura mater.

The *recurrent branch* of the supra-maxillaris takes origin by several fine roots, and runs outwards to the anterior branch of the middle meningeal artery. It communicates with the fine filaments of the recurrent branch of the infra-maxillary division of the fifth nerve (p. 317).

The *ophthalmic division* is the smallest of the three parts of the trigeminal nerve, and, like the supra-maxillary, it is entirely composed of sensory fibres. It proceeds forwards in the outer wall of the cavernous sinus, and ends close to the sphenoidal fissure by dividing into three terminal

branches. As it traverses the sinus it is accompanied by the oculomotor and trochlear nerves, both of which occupy a higher level. Like the other two divisions of the trigeminal nerve, the ophthalmic nerve gives off a recurrent branch to the dura mater.

The *recurrent branch* springs from the ophthalmic nerve close to its origin, and runs backwards for a short distance in the sheath of the fourth nerve. After leaving this nerve it breaks up into fine terminal filaments, which are distributed between the two layers of the dura mater in the neighbourhood of the superior petrosal sinus.

The terminal branches of the ophthalmic division of the trigeminal nerve are the nasal, the lachrymal, and the frontal. The *nasal*, as a rule, takes origin first; soon after, the *lachrymal* is given off, and then the stem of the nerve is continued onwards as the *frontal*. These three nerves enter the orbit through the sphenoidal fissure.

The Third or Oculomotor, Fourth or Trochlear, and Sixth or Abducent Nerves.—The *oculomotor and trochlear nerves*, as the dissector has previously noted, pierce the dura mater within the small triangular area, which is formed by the divergence of the attached and free margins of the tentorium. They now proceed forwards in the outer wall of the cavernous sinus. The third or oculomotor nerve occupies the highest level, then comes the fourth or trochlear nerve, and immediately below this is the ophthalmic division of the fifth or trigeminal nerve. They therefore present a numerical order from above downwards. The *sixth or abducent nerve*, which pierces the dura mater at the lower and outer part of the dorsum sellæ, will be observed to wind round the outer side of the internal carotid artery, and then to proceed forwards more directly within the cavernous sinus than the others and at a lower level.

The oculomotor, trochlear, and abducent nerves give off no branches during their course in relation to the cavernous sinus. They all enter the orbit by passing through the sphenoidal fissure. Before doing so, the oculomotor nerve

divides into an upper and a lower division. During their passage through the sphenoidal fissure the various nerves undergo a change in their relative positions. This, however, will be studied in the dissection of the orbit when that fissure is opened up.

Internal Carotid Artery.—The intracranial portion of the internal carotid artery may now be examined. It lies upon the lateral aspect of the body of the sphenoid, and for the greater part of its course it traverses the cavernous sinus. It enters the cranium by emerging from the carotid canal at the apex of the petrous bone, and it first ascends vertically until it reaches the root of the posterior clinoid process; here it makes a bend and is prolonged forwards to the inner aspect of the anterior clinoid process where it abruptly turns upwards and pierces the dura mater immediately behind the entrance of the optic nerve into the optic foramen. At this point it has been severed in the removal of the brain, but it will be afterwards seen to end at the commencement of the Sylvian fissure of the brain, by dividing into the anterior and middle cerebral arteries. Throughout its whole course it is surrounded by sympathetic filaments, and soon after its entrance into the cranium, the abducent nerve winds round its outer side.

The intracranial portion of the internal carotid artery gives off the following branches:—

1. Branches to the pituitary body, 2. Branches to the Gasserian ganglion, 3. Branches to the dura mater,	These are minute twigs which arise in the cavernous sinus.
4. Ophthalmic, 5. Posterior communicating, 6. Anterior cerebral, } terminal 7. Middle cerebral, } branches.	These will studied at a later stage.

The Cavernous Plexus.—The sympathetic filaments which form this plexus can only be satisfactorily dissected in a subject which has not been injected, and even then, the dissection is an exceedingly difficult one. The *cavernous*

plexus is placed in the cavernous sinus and is chiefly massed upon the lower and inner aspect of the internal carotid artery, at the point where it makes its final bend upwards. It supplies filaments to the pituitary body, to the third and fourth nerves, and to the ophthalmic division of the fifth or trigeminal nerve, and likewise the sympathetic root to the lenticular or ophthalmic ganglion.

Great Superficial Petrosal Nerve.—This minute nerve, along with a small arterial twig from the middle meningeal artery, can readily be exposed in the groove on the anterior face of the petrous bone which leads outwards to the hiatus Fallopii. It is placed under cover of the Gasserian ganglion, which must therefore be turned forwards and outwards. Entering the hiatus Fallopii, the great superficial petrosal nerve is conducted to the aqueduct of Fallopius, where it joins the geniculate ganglion of the facial nerve. If traced in the opposite direction, it will be found at the posterior aspect of the body of the sphenoid bone to join the *large deep petrosal nerve* from the carotid plexus. The trunk formed by the union of these two filaments is the *Vidian nerve.*

The Small Superficial Petrosal Nerve appears upon the anterior face of the petrous bone through an aperture which is placed immediately external to the hiatus Fallopii. It leaves the cranial cavity by passing downwards between the great wing of the sphenoid, and the petrous part of the temporal bone to reach the otic ganglion. This minute nerve, as has already been mentioned (p. 342), is formed by the union of the tympanic branch of the glossopharyngeal with a branch from the geniculate ganglion of the facial.

External Superficial Petrosal Nerve.—It is convenient at this stage to take note of a third petrosal nerve—*the external superficial petrosal.* It takes origin from the sympathetic plexus, which accompanies the middle meningeal artery, and entering the petrous bone, is conducted to the geniculate ganglion of the facial nerve.

Middle and Small Meningeal Arteries.—The entrance of the *middle meningeal artery* through the foramen spinosum should now be examined. It gives minute twigs to the

Gasserian ganglion, and one—the petrosal artery—which accompanies the great superficial petrosal nerve into the hiatus Fallopii. The farther course of the middle meningeal artery has already been described (pp. 133 and 315). The small recurrent branch of the inferior maxillary division of the fifth nerve also enters the cranium through the foramen spinosum (p. 316.)

The *small meningeal artery* enters the cranium through the foramen ovale, and is chiefly distributed to the Gasserian ganglion.

DISSECTION OF THE ORBIT AND OF THE STRUCTURES PASSING THROUGH THE SPHENOIDAL FISSURE.

Within the orbital cavity we find grouped around the eyeball and the optic nerve the following structures :—

Muscles, . .
- Rectus superior.
- Rectus inferior.
- Rectus externus.
- Rectus internus.
- Obliquus superior.
- Obliquus inferior.
- Levator palpebræ superior.

Vessels, . .
- Ophthalmic artery and its branches.
- Ophthalmic veins (superior and inferior) with their tributaries.

Nerves, . .
- Oculomotor (3rd cranial).
- Trochlear (4th cranial).
- Abducent (6th cranial).
- Frontal, Lachrymal, Nasal, — from ophthalmic division of the trigeminal or fifth cranial nerve.
- Orbital branch of the superior maxillary division of the trigeminal or fifth cranial nerve.

Lenticular ganglion.
Lachrymal gland.
The capsule of Tenon.

Dissection.—The roof of the orbit must be removed. The greater part of this dissection should be done with a sharp chisel. Begin by removing the thick cranial wall above the orbital opening, leaving only a thin portion corresponding to the superior orbital arch. Whilst this is being done care should be taken to preserve the soft parts of the forehead and the upper eyelid. It is of great advantage to retain throughout the whole examination of the orbital cavity the bony ring which constitutes its opening on the face. The thin roof of the orbit may next be removed with the chisel. The lesser wing of the sphenoid, where it forms the upper boundary of the sphenoidal fissure, should be taken away by the bone-pliers, but the dissector should carefully preserve intact the ring of bone around the optic foramen. The sphenoidal fissure is now fully opened up, and the various nerves, as they enter the orbit from the cavernous sinus, may be followed out. Lastly, the anterior clinoid process may be taken away with advantage.

Periosteum.—If the above dissection has been successfully carried out, the periosteum clothing the under surface of the orbital roof will be exposed uninjured. The periosteum of the orbit forms a funnel-shaped sheath, which encloses all the contents of the cavity, and is but loosely attached to its bony walls. Behind, it will be observed to be directly continuous through the sphenoidal fissure with the dura mater. Expanding with the cavity, it becomes continuous in front around the orbital opening with the periosteum, which clothes the exterior of the skull. Here also it presents important connections with the palpebral ligaments (p. 295).

Reflection of the Periosteum and the Subsequent Dissection.—The periosteum should be divided along the middle line of the orbit, and also transversely as far forwards as possible. It can now be thrown inwards and outwards. When this is done the lachrymal gland will be exposed in the fore and outer part of the cavity resting upon the upper and outer aspect of the eyeball. Further, the large frontal nerve, lying upon the upper surface of the levator palpebræ superioris, will be seen stretching forwards in the middle line of the orbit ; as it approaches the the fore part of the cavity, it is joined by the supra-orbital artery. The other superficial structures are usually more or less obscured by the soft pliable fat, which everywhere fills up the interstices between the different orbital contents. On carefully separating this, along the inner wall of the orbit, the superior oblique muscle will be more fully displayed, and

lying upon and entering the hinder part of this muscle the small trochlear or fourth cranial nerve will be discovered. As a general rule the dissector fails to find this nerve, because he looks for it too far forwards. Lastly, the lachrymal nerve and artery will be found running along the outer wall of the orbit, above the level of the upper margin of the external rectus muscle.

These structures must be thoroughly cleaned and isolated by the removal of the fat from around them. In tracing the superior oblique muscle forwards, it will be found to end in a slender tendon, which passes through a ring-like pulley, attached to the frontal bone at the inner angle of the orbit. This pulley must be defined, and the tendon of the muscle followed onwards to its insertion into the eyeball. It will be observed that the levator palpebræ superioris lies upon the upper surface of the superior rectus, and if it be raised, a nerve twig will be noticed emerging from the substance of the rectus superior for the supply of the levator palpebræ muscle. This is a branch of the superior division of the third nerve.

The dissection of the above parts will be facilitated by grasping the front of the eyeball with the forceps, and drawing it forwards. It may be retained in this position by running a fine needle and thread through the ocular conjunctiva and stitching it to the nose. In doing this, however, take care that the needle does not penetrate the cornea, because this might render the subsequent inflation of the eyeball impossible.

Frontal Nerve.—The frontal nerve is the continuation of the stem of the ophthalmic division of the trigeminal or fifth nerve, after it has given off its lachrymal and nasal branches. It enters through the sphenoidal fissure above the muscles, and proceeds forwards upon the upper surface of the levator palpebræ superioris immediately subjacent to the periosteal lining of the orbital cavity. At a variable distance from the orbital opening, it ends by dividing into the supra-orbital and supra-trochlear nerves.

The *supra-trochlear nerve* is the inner and smaller of the two terminal branches of the frontal. It runs towards the pulley of the superior oblique muscle, above which it leaves the orbit, by turning round the orbital arch to reach the forehead. Its further course has already been described (pp. 106 and 285). In the orbit it gives off one small twig close to the pulley of the superior oblique muscle. This

passes downwards to join the infra-trochlear branch of the nasal nerve.

The *supra-orbital nerve* is continued forward in the line of the parent stem, and, passing through the supra-orbital notch or foramen, it turns upwards on the forehead (pp. 106 and 285). In the dissection of the scalp this nerve has been seen to divide into an outer and inner division. Sometimes this division takes place within the orbit, and in that case the *outer* larger part occupies the supra-orbital notch.

The Lachrymal Nerve is the smallest of the terminal branches of the ophthalmic division of the fifth. It enters the orbit through the sphenoidal fissure above the level of the muscles, and proceeds forwards along the outer wall of the cavity, and above the upper margin of the external rectus muscle. At the fore part of the orbit it continues its course under cover of the lachrymal gland until it reaches the outer part of the upper eyelid, in which it ends (p. 286). Within the orbital cavity it gives numerous twigs to the deep surface of the lachrymal gland, and sends downwards a filament which connects it with the orbital branch of the superior maxillary nerve.

Trochlear, or Fourth Cranial Nerve.—This small nerve is destined entirely for the supply of the superior oblique muscle. Entering the orbit through the sphenoidal fissure above the muscles, it is continued forwards and inwards under the periosteum. It finally sinks into the upper or orbital surface of the superior oblique muscle not far from its origin.

Lachrymal Gland.—The lachrymal gland is a small flattened body of an oval form, and distinctly lobular structure, which is placed obliquely in the fore and outer part of the orbital cavity. It consists of two parts or groups of lobules—an orbital and a palpebral—imperfectly separated from each other. The *orbital part* (portio superior s. orbitalis) constitutes the main mass of the gland. Its outer surface is convex, and is lodged in a hollow upon the inner aspect of

the external angular process of the frontal bone. It is bound to the outer part of the orbital arch by short fibrous bands which proceed from the periosteum. The deep or inner surface is slightly concave, and is directed inwards and downwards towards the eyeball. The small *palpebral lobe* (portio inferior s. palpebralis) is placed in front of the orbital part, from which it is partially separated by the expanded tendon of the levator palpebræ superioris. It projects into the back part of the upper eyelid, and rests upon the conjunctiva which lines the under aspect of the lid. This portion of the gland has been already examined in the dissection of the eyelids (p. 298); but even in the undissected subject it can be seen through the conjunctiva if the upper eyelid be fully everted.

The lachrymal gland secretes the tears, and its ducts (three to five from the orbital part and three to nine from the palpebral part) open upon the under surface of the upper eyelid in the neighbourhood of the fornix (p. 299).

The Levator Palpebræ Superioris rests upon the upper surface of the rectus superior. Behind it is narrow and pointed, but it expands as it passes forwards above the eyeball to reach the upper eyelid. It arises from the under surface of the roof of the orbit immediately in front of the optic foramen, and in the fore part of the orbital cavity it widens out into a broad membranous expansion, the connections of which have already been described (p. 297). The outer and inner margins of this expansion are fixed to the rim of the orbital opening, in close proximity to the external and internal tarsal ligaments. By these attachments excessive action of the muscle upon the upper eyelid is in a measure checked.

Dissection.—The frontal nerve should be divided, and the ends thrown forwards and backwards. The levator palpebræ superioris may also be cut midway between its origin and insertion. On raising the posterior portion a minute nervous twig will be observed entering its deep or ocular surface. This comes from the superior division of the third or oculomotor nerve.

The eyeball should now be inflated. This may be done from the front or from behind. If the latter method is selected gently separate the fat under cover of the superior rectus muscle, and, pushing aside the ciliary nerves and vessels from the optic nerve, place a ligature around it close to the eyeball. A minute aperture should next be made in the sheath of the nerve behind the ligature, and, introducing a blow-pipe into this, thrust it forcibly forwards into the interior of the eyeball. The pipe should be provided with a stylette so as to keep the aperture free. When the globe of the eye is fully inflated, the ligature may be tightened as the blow-pipe is withdrawn. A very much better plan, however, is to inflate the eyeball from the front. For this purpose an oblique valvular aperture is made in an inward direction through the sclero-corneal junction with the point of a sharp narrow bladed knife. Through this the blow-pipe may be introduced, and on its withdrawal after the inflation of the eyeball the valvular character of the opening is sufficient to prevent the escape of the air.

At the back of the eyeball the dissector will notice a quantity of loose bursal-like tissue. This is the *Capsule of Tenon.* Seize the upper part of this with the forceps, and remove a small portion with a pair of scissors. An aperture is thus made into the capsule, and the handle of the knife can be introduced into the space between it and the eyeball. In favourable cases the extent of the capsule can be gauged, and perhaps even the prolongations or sheaths which it gives to the tendons of the ocular muscles made out. The description of the capsule of Ténon is given in p. 376.

Rectus Superior.—The rectus superior, which lies under cover of the levator palpebræ superioris, is now fully exposed. It arises from the upper margin of the optic foramen, and, passing forwards above the optic nerve, ends upon the upper aspect of the eyeball in a thin, delicate tendon, which expands somewhat to be inserted into the sclerotic coat about three or four lines behind the sclero-corneal junction. It is supplied by a branch from the superior division of the oculomotor nerve.

The Superior Oblique Muscle arises from the roof of the orbit immediately in front of the upper and inner part of the optic foramen, and extends forwards along the inner wall of the cavity above the internal rectus. At the fore part of the orbit it ends in a slender tendon, which enters the *pulley* and at once changes its direction. It now pro-

ceeds outwards and slightly backwards upon the upper surface of the eyeball, and under cover of the superior rectus. Beyond the outer edge of the latter muscle the tendon expands somewhat, and is inserted into the sclerotic coat midway between the entrance of the optic nerve and the cornea.

The *pulley* through which the tendon passes is a small fibro-cartilaginous ring, which is attached by fibrous tissue to the trochlear fossa—a depression in the frontal bone close to the internal angular process. The pulley is lined by a small synovial sheath which facilitates the movement of the tendon within it, and from its outer margin it gives a fibrous investment to the tendon.

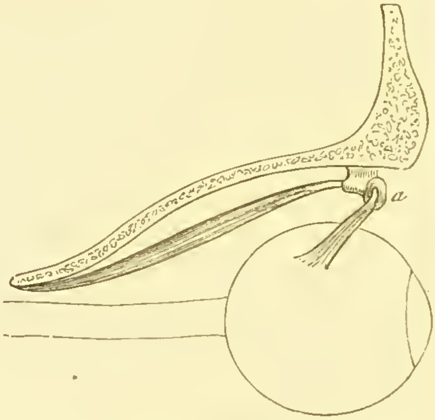

FIG. 242.—Diagram of the superior oblique muscle. (From HERMANN MEYER.)

a. Pulley and synovial sheath.

Dissection.—The superior rectus muscle should now be divided midway between its origin and its insertion, and the cut ends thrown backwards and forwards. On raising the posterior part of the muscle the superior division of the third nerve is brought into view, and will be seen to sink into its deep or ocular surface, and at the same time send a twig to the levator palpebræ superioris. The removal of some fat will bring the optic nerve more fully into view. At the back part of the orbit three structures will be observed crossing the optic nerve —viz. (1) the nasal nerve; (2) the ophthalmic artery; and (3) the superior ophthalmic vein. These should be carefully cleaned and their branches followed out. From the nasal nerve, one or two delicate thread-like branches—the *long ciliary nerves*—will be found passing forwards along the optic nerve to reach the eyeball. The *short ciliary nerves*, much more numerous, accompany the long ciliary branches, and can readily be disengaged from the fat which surrounds the optic nerve. A strong member of this group should be selected and followed backwards; it

will lead the dissector to the *lenticular* or *ophthalmic ganglion.* This is a minute body which is situated upon the outer side of the optic nerve far back in the orbit. With a little patience and care the roots which the nasal nerve and inferior division of the oculomotor or third nerve give to this ganglion can be isolated, and perhaps even the sympathetic root from the cavernous plexus may be found.

Optic Nerve.—The optic nerve enters the orbit through the optic foramen. It carries with it a strong loose sheath of dura mater, and also a more delicate investment from the arachnoid. The ophthalmic artery which accompanies it lies in relation to its outer and lower aspect. Within the orbit the nerve inclines forwards and outwards, and at the same time somewhat downwards, and, gaining the back of the eyeball, it pierces the sclerotic coat a short distance to the inner side of its centre. As the dissector has already observed, its upper surface is crossed by the ophthalmic artery and vein and the nasal nerve, and it is closely accompanied by the delicate ciliary nerves and vessels. The distance which the optic nerve has to run from the optic foramen to the globe of the eye is about one inch. Within the eyeball, it spreads out in the retina.

Nasal Nerve (nervus naso-ciliaris).—The nasal nerve arises in the fore part of the cavernous sinus from the ophthalmic division of the trigeminal. It passes through the sphenoidal fissure and enters the orbital cavity between the two heads of the external rectus muscle, and between the two divisions of the third nerve. It now inclines forwards and inwards, and, crossing the optic nerve obliquely, it runs between the internal rectus and superior oblique muscles. Here it reaches the inner wall of the orbit, and ends by dividing into two terminal branches—viz., the infra-trochlear and the nasal proper. In addition to these it gives off in the orbit the following branches :—

1. Long root to the lenticular ganglion.
2. Long ciliary nerves.

The *long ganglionic root* is a very slender filament which springs from the nasal as it enters the orbit between the

heads of the external rectus. It proceeds forwards on the outer side of the optic nerve, and enters the upper and back part of the lenticular ganglion.

The *long ciliary nerves*—usually two in number—spring from the nasal as it crosses the optic nerve. They proceed forwards upon the inner side of the optic nerve to reach the globe of the eye, where they pierce the sclerotic. One of the long ciliary nerves very constantly unites with one of the short ciliary filaments.

The *infra-trochlear nerve* runs forwards along the inner wall of the orbit under cover of the superior oblique. Passing under the trochlea of that muscle, it emerges from the orbit and appears upon the face where it has already been dissected (p. 287). Near the pulley it receives a communicating twig from the supra-trochlear nerve.

The *nasal proper* is the larger of the two terminal branches of the nasal nerve. It leaves the orbit by the anterior internal orbital canal, and is conducted to the interior of the cranium, in which it appears at the outer margin of the cribriform plate of the ethmoid. The canal in which it runs can readily be opened up by the bone-pliers and the nerve exposed within it. Upon the cribriform plate it turns forwards under the dura mater, and almost immediately disappears through a slit-like aperture at the side of the crista galli, to reach the nasal cavity. Here it gives branches to the mucous membrane, and is continued downwards upon the posterior aspect of the nasal bone. Finally, it emerges upon the face by passing between the lower margin of the nasal bone and the upper lateral cartilage of the nose. Its terminal filaments have already been described (p. 287).

The *nasal nerve proper*, therefore, takes a most circuitous route, being found—(1) in the orbit; (2) in the cranium; (3) in the nasal fossa; and (4) in the face.

Lenticular Ganglion.—The lenticular or ophthalmic ganglion is a minute quadrangular body, not much larger than the head of a large pin; but its size varies considerably

in different subjects. It is placed in the back part of the orbit between the optic nerve and the external rectus muscle, and very commonly on the outer side of the ophthalmic artery. By its posterior border it receives its three roots ; whilst from its anterior border the short ciliary nerves are given off.

The *sensory root* comes from the nasal, and is called the *long root.* It enters the upper and hinder angle of the ganglion. The *short* or *motor root* is a short, stout trunk ; it comes from the branch of the oculomotor nerve, which

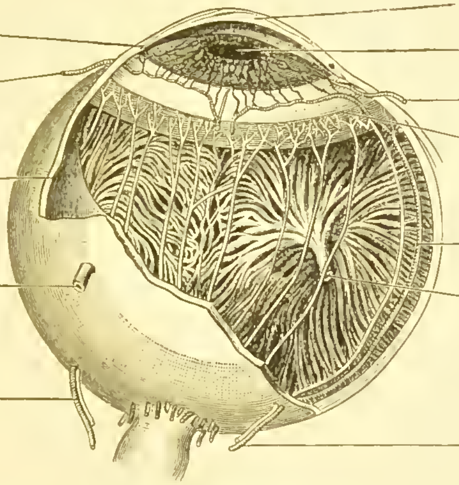

FIG. 243.—Dissection of the eyeball showing the distribution of the ciliary nerves and vessels.

goes to the inferior oblique muscle, and it enters the lower and hinder angle of the ganglion. The *sympathetic root* comes from the cavernous plexus, and joins the posterior border of the ganglion, close to the entrance of the long root from the nasal nerve. In some cases it joins the long root before it reaches the ganglion.

The *short ciliary nerves* are from four to six in number, and they come off in two groups, of which one emerges from the upper and fore angle of the ganglion, whilst the other

springs from its lower and fore angle. The lower group is generally more numerous than the upper. As these fine nerves proceed along the optic nerve they divide, and thus increase in number; at the back of the eyeball from twelve to eighteen may be counted. Finally they pierce the sclerotic by a series of apertures which are placed around the entrance of the optic nerve.

The Ophthalmic Artery (arteria ophthalmica) is a branch of the internal carotid, and it accompanies the optic nerve into the orbit through the optic foramen. At first it lies below the optic nerve, but it soon winds round the outer side of the nerve, and crossing it superficially proceeds forwards along the inner wall of the orbit, under cover of the superior oblique muscle. At the inner angle of the orbit, it ends by dividing into two terminal branches—viz., the frontal and the nasal (Fig. 244).

The *branches* of the ophthalmic artery are very numerous, and they can seldom be satisfactorily displayed, unless a special injection has been made, or a cold injection used. They are:—

1. The lachrymal.
2. Muscular.
3. Arteria retinæ centralis.
4. Ciliary.
5. Supra-orbital.
6. Ethmoidal.
7. Palpebral.
8. Nasal.
9. Frontal.

The *lachrymal artery* (arteria lacrimalis) accompanies the lachrymal nerve, and supplies the gland of that name and the conjunctiva. Two branches, named *external palpebral* (arteriæ palpebrales laterales), form an arch (arcus tarseus) in each eyelid, near the free margin, with the internal palpebral arteries.

The *muscular twigs* (rami musculares) come off at variable points, not only from the main artery, but also from certain of its branches. They supply the muscles contained in the orbital cavity.

The *arteria retinæ centralis* is a minute but important

artery. It pierces the optic nerve about a half an inch behind the eyeball, and is conducted in its substance to the interior of the globe of the eye.

The *ciliary arteries* are very numerous. Two groups are recognised—viz., a posterior and an anterior. The *posterior ciliary arteries* run with the ciliary nerves. They arise by two trunks which spring from the ophthalmic whilst it lies below the optic nerve. These divide into several slender branches, which pierce the sclerotic around the entrance of

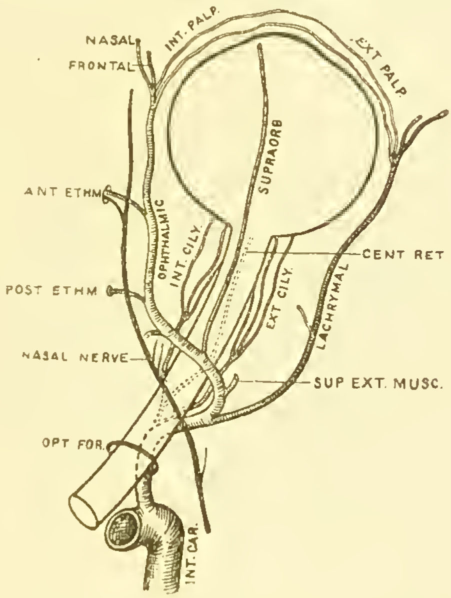

FIG. 244.—Diagram of the ophthalmic artery and its branches. (After QUAIN and MEYER, modified.)

the optic nerve. Two members of this group of vessels enter the eyeball on either side of the optic nerve, somewhat apart from the others. They are termed the *long ciliary arteries* (arteriæ ciliares posteriores longæ) (Fig. 243). The *anterior ciliary arteries* (arteriæ ciliares anteriores) come off in the fore part of the orbit from the lachrymal and muscular branches. They vary in number from six to eight, and run to the anterior part of the eyeball, where they form an

arterial circle under the conjunctiva. Finally, they pierce the sclerotic immediately behind the cornea.

The *supra-orbital artery* (arteria supraorbitalis) accompanies the supra-orbital nerve, and thus gains the forehead, where it has been dissected at a previous stage (p. 110).

The *ethmoidal arteries* are two in number—anterior and posterior—and they run to the anterior and posterior internal orbital foramina on the inner wall of the orbit. The *posterior ethmoidal artery* (arteria ethmoidalis posterior) supplies the mucous lining of the posterior ethmoidal cells, and sends twigs to the upper part of the nose. The *anterior ethmoidal artery* (arteria ethmoidalis anterior) is a larger branch. It runs in company with the nasal nerve proper, and gives off minute twigs at each stage of its course. Thus in the anterior internal orbital canal it gives branches to the mucous lining of the anterior ethmoidal cells and the frontal sinus; during its short sojourn in the cranial cavity it supplies the small *anterior meningeal artery* (arteria meningea anterior) (p. 134); in the nasal cavity it gives twigs to the mucous membrane; whilst its terminal branch appears on the face to supply parts on the side of the nose.

The *internal palpebral branches* (arteria palpebrales mediales) come off near the orbital opening, and are two in number—one for the upper and the other for the lower eyelid (p. 298).

The *nasal branch* (arteria dorsalis nasi) is distributed at the root of the nose, and anastomoses with the angular branch of the facial artery.

The *frontal artery* (arteria frontalis) accompanies the supra-trochlear nerve to the forehead, where it has already been dissected (p. 110).

The Ophthalmic Veins.—As a general rule these are two in number—superior and inferior. The *superior ophthalmic vein* is the larger of the two, and it accompanies the artery across the optic nerve. It takes origin at the root of the nose, where it communicates by a wide radicle with the

angular vein. The *inferior ophthalmic vein* lies deeper, below the level of the optic nerve, and it is brought into communication with the pterygoid venous plexus by an offset which passes through the spheno-maxillary fissure. The two ophthalmic veins receive numerous tributaries during their course through the orbit, and finally they pass between the two heads of the external rectus muscle, and through the sphenoidal fissure to open into the cavernous sinus, either separately or by a common trunk.

The Recti Muscles.—The four straight muscles of the eyeball converge to the apex of the orbit, and together form

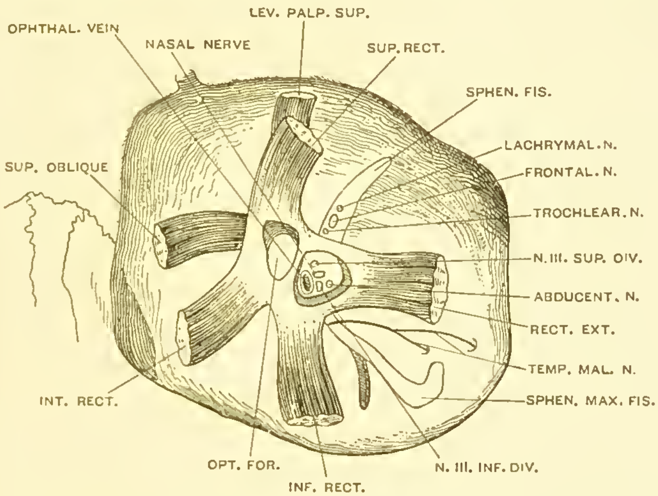

FIG. 245.—Diagram of the orbital cavity and of the origin of the ocular muscles in relation to the optic foramen and the sphenoidal fissure.

the sides of a four-sided or pyramidal space, in which are enclosed the optic nerve and the greater part of the globe of the eye. The *rectus superior*, which has been reflected, has already been studied. The *rectus internus* springs from the inner side of the optic foramen, and the *rectus inferior* takes origin from a fibrous band which bounds the inner extremity of the sphenoidal fissure (Fig. 245). The *rectus externus* is distinguished from the others by arising from a

fibrous arch, the extremities of which are termed its two heads of origin. The *lower head* arises in common with the rectus inferior from the body of the sphenoid, where this bounds the inner end of the sphenoidal fissure; the *upper head* is attached above the sphenoidal fissure upon the outer side of the optic foramen where its origin becomes continuous with that of the superior rectus. Through the archway which intervenes between the two heads of the external rectus pass the two divisions of the oculomotor nerve, the nasal nerve, the abducent nerve, and the ophthalmic veins (Fig. 245).

When the ocular surfaces (*i.e.*, the surfaces turned towards the optic foramen) of these muscles are examined, they will be seen to arise in a great measure from two common tendons which, from their position and connections, may be termed the superior and inferior common tendons of the recti muscles. The *superior common tendon* (Lockwood) springs from the upper and outer margin of the optic foramen, and gives origin to the superior rectus, the internal rectus, and the upper head of the external rectus. The *inferior common tendon*, more usually known as the "Ligament of Zinn," arises from a distinct depression upon the lower and outer aspect of the margin of the optic foramen, and divides into three slips, which go to the internal rectus, the inferior rectus, and the lower head of the external rectus. The slips, from the two common tendons which go to the external rectus become continuous with each other, forming in this way the tendinous arch referred to.

A better view of these attachments may be obtained by dividing the optic nerve close to the optic foramen and turning forwards the eyeball.

The manner in which the recti muscles are inserted into the eyeball should next be studied. Each ends in a delicate membranous tendon, which is inserted into the sclerotic coat, about a quarter of an inch behind the sclero-corneal junction.

The Oculomotor or Third Nerve.—The two divisions of this nerve enter the orbit through the sphenoidal fissure, between the two heads of the external rectus. The *superior division* has been traced to the rectus superior and the levator palpebræ superioris. The *inferior division* is much the larger of the two, and almost immediately divides into three branches for the supply of the rectus internus, the

rectus inferior, and the inferior oblique. The nerves to the two recti enter the ocular surfaces of these muscles; the nerve to the inferior oblique is a long branch, which is prolonged forwards in the interval, between the rectus inferior and rectus externus, and enters the hinder border of the inferior oblique muscle. Soon after its origin this branch gives the *short motor root* to the lenticular ganglion, and likewise supplies two or three additional filaments to the inferior rectus muscle.

The Abducent or Sixth Nerve will be found closely applied to the ocular surface of the external rectus, and it enters the orbit by passing through the narrow interval between the heads of this muscle. It is destined entirely for the supply of the rectus externus.

Arrangement of the Nerves in the Sphenoidal Fissure.—Now that the orbit is dissected, and the various nerves which were met in the dissection of the cavernous sinus traced into the cavity, the dissector will observe that the arrangement of these nerves in the sphenoidal fissure is somewhat different from that in the sinus.

The lachrymal, frontal, and trochlear or fourth nerves enter the orbit above the muscles on very much the same plane (Fig. 245). The other nerves enter between the heads of the external rectus. Of these the superior division of the oculomotor nerve is the highest, next comes the nasal nerve, then the inferior division of the oculomotor nerve, whilst the abducent nerve occupies the lowest level.

Dissection.—The inferior oblique muscle is placed very differently from the other muscles of the orbit. It is situated below the eyeball, and turns round its inferior and outer surface. It must be dissected from the front. It is necessary therefore to restore the eyeball to its natural place. Next, evert the lower eyelid and remove the conjunctiva from its deep surface as it is reflected on to the globe of the eye. A little dissection in the floor of the fore part of the orbit and the removal of some fat will reveal the inferior oblique muscle.

The Inferior Oblique Muscle arises from a small depression on the orbital plate of the superior maxillary bone immedi-

ately to the outer side of the opening of the nasal duct. It passes outwards below the inferior rectus muscle, and, inclining slightly backwards, ends in a thin membranous tendon, which gains insertion into the outer aspect of the sclerotic coat of the eyeball under cover of the rectus externus. This insertion is not far from that of the superior oblique, but is placed farther back. A branch of the inferior division of the third nerve has been traced to the posterior margin of the inferior oblique muscle.

The Capsule of Tenon is a firm, loose membrane in relation to the globe of the eye. Its connections are somewhat complicated, and they cannot in every detail be satisfactorily displayed in an ordinary dissection. It may be studied from a three-fold point of view—(1) in its connection with the eyeball; (2) in its connections with the muscles inserted into the globe of the eye; and (3) in its connections with the walls of the orbit.

The relation which the capsule of Tenon exhibits to the eyeball is very simple. The membrane is spread over the posterior five-sixths of the globe—the cornea alone being free from it. In front it lies under the ocular conjunctiva, with which it is intimately connected, and it ends by blending with the conjunctiva close to the margin of the cornea. Behind it fuses with the sheath of the optic nerve, where the latter pierces the sclerotic. The anterior surface of the membrane (*i.e.*, the surface towards the globe of the eye) is smooth, and is connected to the eyeball by some soft yielding and humid areolar tissue, the interval between them in fact constituting an extensive lymph space. Its posterior surface is in contact with the orbital fat, to which it is loosely adherent, while farther forwards, as we have noted, this surface is firmly attached to the ocular conjunctiva. It is apparent, therefore, that by this membrane a socket is formed for the eyeball, in which it can glide with the greatest freedom.

The tendons of the various ocular muscles are inserted

into the eyeball within this capsule, and they gain its interior by piercing the membrane opposite the equator of the globe (Fig. 246). The lips of the openings through which the four recti muscles pass are prolonged backwards upon the muscles, in the form of sheaths, very much in the same manner that the infundibuliform fascia is prolonged upon the spermatic cord from the internal abdominal ring. These sheaths gradually become more and more attenuated, until at last they blend with the perimysium of the muscular bellies. In the case of the superior oblique muscle the corresponding prolongation is only related to its reflected portion; it reaches the pulley and there it ends by becoming attached to its margin. The sheath of the inferior oblique may be traced upon the muscle as far as the floor of the orbit. The inner or ocular edge of each of the four apertures through which the recti muscles pass is strengthened by a vertical slip of fibrous tissue (Lockwood). The importance of these slips will be understood when we remember that the capsule of Tenon is at various points firmly bound to the bony wall of the orbit. They therefore act as pulleys, and protect the globe of the eye from pressure during contraction of the muscles. The aperture for the superior oblique is not furnished with such a slip, and it is doubtful if the opening for the inferior oblique muscle possesses one.

Dissection.—An admirable view of the relations which the capsule of Tenon presents to the eyeball and the tendons of the ocular muscles can be obtained by the following dissection :—Divide the outer canthus of the eyelids as far out as the margin of the orbital opening. Pull the eyelids widely apart, so as to expose as much as possible of the anterior face of the eyeball. Next divide the conjunctiva by a circular incision just outside the cornea. At this point the capsule of Tenon is so intimately connected with the conjunctiva that it is divided at the same time. Now raise carefully both conjunctiva and Tenon's capsule from the surface of the eyeball, and spread them out round the orbital opening, as is depicted in Fig. 246. The openings in the capsule of Tenon for the tendons of the ocular muscles and the thickened margins of these apertures are well seen. Note also the sheaths which are given to the muscles.

Check and Suspensory Ligaments.—The connections of the capsule of Tenon to the walls of the orbital cavity are somewhat complicated. The *suspensory ligament* (Lockwood) is perhaps the most important of these. It stretches across the fore part of the orbit, after the fashion of a hammock, and gives support to the eyeball. Its two extremities are narrow, and are attached respectively to the malar and lachrymal bones. Below the eyeball it widens out and blends with the capsule of Tenon. The *external* and *internal check ligaments* also constitute bonds of union between

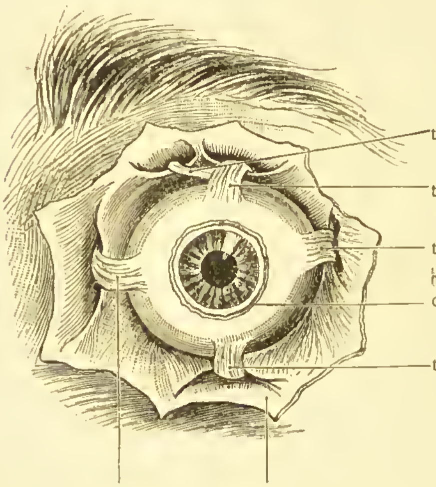

FIG. 246.—Dissection of the capsule of Tenon from the front.

the capsule of Tenon and the orbital wall. They are strong bands which pass from the sheaths around the external and internal recti muscles to obtain attachment to the malar and lachrymal bones respectively; here they are brought into association with the extremities of the suspensory ligament. The function of the check ligaments is easily understood. They limit the contraction of the external and internal recti muscles, and thus prevent excessive rotation of the eyeball in an outward or inward direction. There is a similar but

less direct provision by means of which the action of the superior and inferior recti muscles is limited. The action of the former muscle is checked through its intimate connection with the levator palpebræ superioris in the fore part of the orbit; the action of the inferior rectus is checked through its connection with the suspensory ligament.[1]

Dissection.—In order that the temporo-malar, or orbital branch of the superior maxillary division of the trigeminal nerve, may be displayed in its course through the orbit, the orbital contents must be removed. It will then be found in the midst of a little soft fat in the angle between the floor and outer wall of the orbit.

The Temporo-Malar Nerve arises in the spheno-maxillary fossa, from the superior maxillary division of the trigeminal nerve, and it enters the orbit by passing through the spheno-maxillary fissure. It almost immediately divides into two terminal branches—viz., the temporal and the malar.

The *temporal branch* runs forwards and upwards upon the outer wall of the orbit, under cover of the periosteum, and, after receiving a communicating twig from the lachrymal nerve, it enters the temporal canal of the malar bone. This conducts it to the fore part of the temporal region, where it has already been examined (pp. 108 and 287).

The *malar branch* (subcutaneus malæ) continues forward in the angle between the floor and outer wall of the orbit, and is finally conducted to the face by a minute canal which perforates the malar bone. Here it has been displayed in the dissection of the face (p. 287).

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[1] For further information regarding the capsule of Tenon the student is referred to the admirable account which is given of its connections by Mr. Lockwood in *Journal of Anatomy and Physiology*, vol. xx., 1885. He points out how important it is for the surgeon in the operation for the removal of the upper jaw to carefully preserve the attachments of the suspensory ligament. If these be destroyed, there is a danger of the eyeball sinking downwards to such an extent that it may afterwards be necessary to remove it.

PREVERTEBRAL REGION.

The following are the structures to be displayed in this dissection :—

Prevertebral muscles.	Vertebral vein.
Intertransverse muscles.	Vertebral and cranio-vertebral articulations.
Cervical nerves.	
Vertebral artery.	

Dissection.—In order that we may obtain a proper view of the pharynx and the prevertebral muscles, it is necessary to make a somewhat complicated dissection. The fore part of the skull bearing the pharynx must be separated from the back part of the skull and the cervical portion of the vertebral column. Place the preparation upside down, so that the cut margin of the skull rests upon the table, and, having divided the common carotid artery, the internal jugular vein, the vagus nerve, and the sympathetic cord on each side at level of the neck of the first rib, draw the trachea and œsophagus, together with the great blood vessels and nerves, forwards from the anterior surface of the vertebral column. This separation must be effected right up to the base of the skull. At this point great caution must be observed, otherwise the pharyngeal wall or the insertions of the prevertebral muscles will be damaged. The base of the skull having been reached, the point of the knife should be carried across the basilar process of the occipital bone between the pharynx and vertebral muscles, so as to divide the thick investing periosteum.

The basilar process must now be divided by means of a chisel. Still retaining the part upside down, place the skull so that its floor rests upon the end of a wooden block. Then apply the edge of the chisel to the under surface of the basilar process, adjust it accurately in the interval between the pharyngeal wall and the prevertebral muscles, and with a wooden mallet drive it through the base of the skull, inclining it, at the same time, slightly backwards.

The next step in the dissection consists in making two saw-cuts through the cranial wall. The head having been placed upon its side, the saw must be applied to the outer aspect of the skull half-an-inch behind the mastoid process, and carried obliquely forwards and inwards to reach a point immediately behind the jugular foramen. The same saw-cut must be repeated upon the opposite side of the head.

To complete the dissection the dissector must again have recourse to the chisel. Placing the preparation so that the floor of the cranium looks upwards, divide the base of the skull, on each side, in the interval

between the petrous portion of the temporal bone and the basilar portion of the occipital bone. In front, this cut should reach the outer extremity of the incision already made through the basilar process; whilst behind, it should be carried backwards upon the inner side of the jugular foramen to reach the inner end of the saw-cut. When this has been done upon both sides of the basilar process, the fore part of the skull carrying the pharynx and the great blood vessels and nerves can be separated from the back part of the skull and cervical portion of the vertebral column. The only large nerve which will be divided is the hypoglossal, but, as it is cut close to the basis cranii, and below this it is firmly connected with the trunk ganglion of the vagus, it retains its position.

The pharynx and anterior portion of the skull should now be covered with a piece of cloth soaked in the spirit and carbolic solution, and the whole enveloped in an oil-cloth wrapper. It can then be laid aside until the dissection of the prevertebral region and the ligaments of the cervical vertebræ and the occiput have been studied.

Returning to the posterior part of the skull and the cervical portion of the spine, the dissector should proceed to define the attachments of the muscles which lie in front of the transverse processes and the bodies of the vertebræ. These are three in number on each side, viz.:—

1. The longus colli.
2. The rectus capitis anticus major.
3. The rectus capitis anticus minor.

The Longus Colli is the most powerful of the prevertebral muscles, and it lies nearest to the mesial plane. Its connections are somewhat intricate, but when it has been thoroughly cleaned it will be seen to consist of three portions —viz., an upper and lower oblique part, and an intermediate vertical part.

The *lower oblique* division of the longus colli (Fig. 247, *b*) arises from the lateral aspect of the bodies of the upper two or three dorsal vertebræ. It extends upwards and slightly outwards, and ends in two tendinous slips which are inserted into the anterior tubercles of the transverse processes of the fifth and sixth cervical vertebræ. In the interval between this portion of the longus colli and the scalenus anticus, the vertebral artery will be observed. The *upper oblique* part of the longus colli (Fig. 247, *c*) arises by three tendinous slips from the anterior tubercles of the transverse processes of the

third, fourth, and fifth cervical vertebræ, and tapers somewhat as it proceeds upwards and inwards, to obtain a pointed and tendinous insertion into the anterior tubercle of the atlas. The *vertical part* of the muscle (Fig. 247, *a*) is much the largest of the three divisions, and it lies along the inner side of the oblique portions, with both of which it is more or less intimately connected. Thus below, it arises in common with the inferior oblique part by two or three slips from the sides of the bodies of the upper two or three dorsal vertebræ; above this it derives additional slips of origin from the bodies of the lower two cervical vertebræ; lastly, its outer border is reinforced by slips from the transverse processes of the lower three or four cervical vertebræ. It stretches vertically upwards and is inserted upon the inner side of the upper oblique part of the muscle, by three tendinous processes, which obtain attachment to the bodies of the second, third, and fourth cervical vertebræ.

The Rectus Capitis Anticus Major (Fig. 247, 1) is an elongated muscle which arises by four tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and is inserted in front of the foramen magnum, upon the under aspect of the basilar process of the occipital bone. To reach this insertion the muscle inclines slightly inwards as it ascends upon the front of the vertebral column. It is supplied by twigs from the first loop of the cervical plexus.

The Rectus Capitis Anticus Minor (Fig. 247, 2, and 248, 2) is a very minute muscle. It is in great part concealed by the upper part of the preceding muscle, which should be detached from its insertion, and turned downwards so as to bring it fully into view. It arises from the anterior aspect of the root of the transverse process of the atlas, and proceeding upwards and inwards is inserted into the under surface of the basilar process of the occipital bone behind the rectus capitis anticus major. It is supplied by a filament from the first loop of the cervical plexus.

Before proceeding farther, the dissector should again examine the attachments of the scalene muscles (*v.* p. 233).

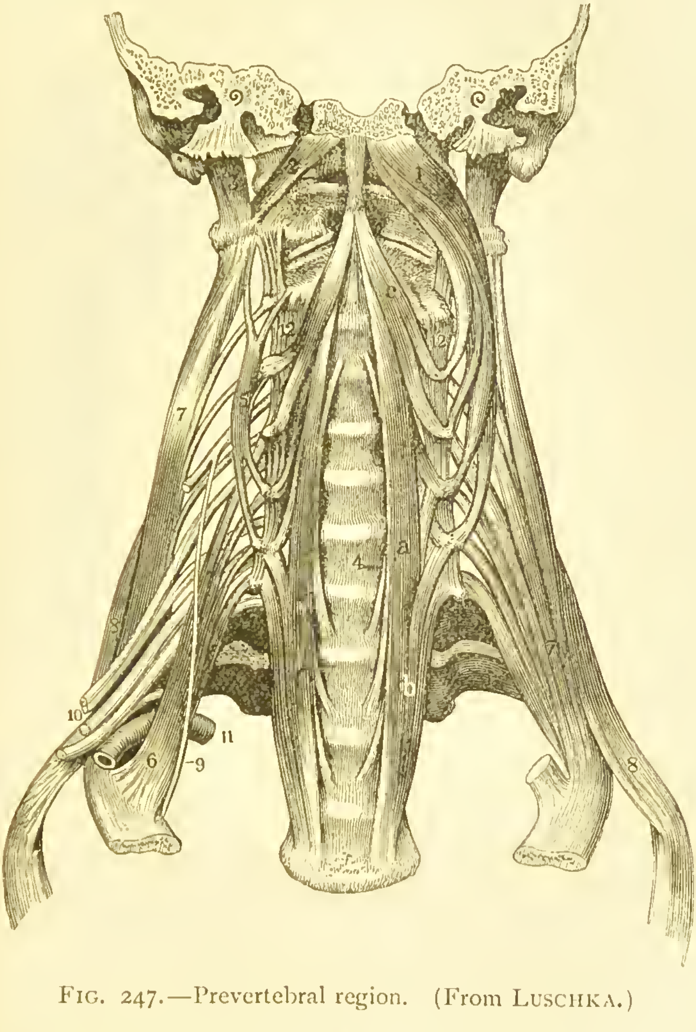

FIG. 247.—Prevertebral region. (From LUSCHKA.)

1. Rectus capitis anticus major.
2. Rectus capitis anticus minor.
3. Rectus lateralis
4. Longus colli { *a.* Vertical part. *b.* Lower oblique part. *c.* Upper oblique part.
5. A supernumerary muscle frequently present, and called by Luschka musculus transversalis cervicis anticus.
6. Scalenus anticus.
7. Scalenus medius.
8. Scalenus posticus.
9. Phrenic nerve.
10. Brachial nerves.
11. Subclavian artery.
12. Intertransverse muscles.

Intertransverse Muscles and Cervical Nerves.—To obtain a proper display of the intertransverse muscles it will be necessary to remove the prevertebral and scalene muscles. The intertransverse muscles consist of seven pairs of small fleshy slips, on each side, which connect the bifid extremities of the cervical transverse processes (Fig. 248, 3). The anterior slip of each muscle is attached to the anterior tubercles of two adjacent transverse processes; whilst the posterior slip extends between the posterior tubercles. The highest pair of muscular slips lies between the atlas and the axis; the lowest pair connects the transverse process of the seventh cervical vertebra with the transverse process of the first dorsal vertebra.

FIG. 248.—The intertransverse muscles.

1. Rectus lateralis.
2. Rectus capitis anticus minor.
3. Intertransverse muscles.
4. Anterior primary divisions of cervical nerves.

The *cervical nerves* will be observed to have a very definite relation to the intertransverse muscles. The anterior primary branches of the lower six cervical nerves make their appearance by passing outwards *between* the two slips of the corresponding muscles. The posterior primary divisions of the same nerves turn backwards *behind* the posterior muscular slips.

The upper two cervical nerves emerge from the spinal canal, as we have already noticed, differently from the others. They pass backwards over the neural arches of the atlas and axis respectively. The *first* or *suboccipital* nerve

has been sufficiently examined at a previous stage of the dissection (p. 351); but the dissector is now in a position to observe that the *anterior primary division* of the *second cervical nerve* turns forwards under cover of the posterior slip of the first intertransverse muscle, and winds round the outer side of the vertebral artery, to appear behind the anterior slip of the same muscle.

Dissection.—The vertebral artery as it traverses the succession of foramina in the transverse processes of the cervical vertebræ should now be exposed. Remove the intertransverse muscles as well as the muscles still attached to the transverse process of the atlas—viz., the rectus lateralis, the inferior oblique, and the superior oblique. The anterior tubercles and the costal portions of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ should then be snipped off by the bone-pliers.

The Vertebral Artery (arteria vertebralis) has previously been traced to the point where it disappears through the foramen in the transverse process of the sixth cervical vertebra; it is now seen to proceed vertically upwards through the succession of foramina transversaria until it reaches the foramen in the transverse process of the axis. In this it is directed outwards in order that it may gain the more outwardly placed foramen of the atlas. Upon the upper surface of the atlas it again changes its direction and proceeds backwards, behind the lateral mass, in a groove on the upper surface of the posterior arch of that bone. Finally, it turns forwards under the posterior occipito-atlantal ligament, pierces the dura mater, and enters the cranium through the foramen magnum.

The vertebral artery is accompanied by a sympathetic plexus of nerves derived from the inferior cervical ganglion, whilst the vertebral vein breaks up in a plexiform manner around it. The anterior divisions of the lower six cervical nerves pass outwards behind it; the corresponding division of the first cervical nerve passes forwards internal to it, whilst that of the second nerve turns forward upon its outer aspect; lastly, the posterior primary division of the first

cervical nerve enters the suboccipital triangle of the neck by passing backwards between the artery and the neural arch of the atlas.

The *branches* which are given off by the vertebral artery in the neck are of small size. They are (*a*) muscular ; (*b*) lateral spinal.

The *muscular twigs* go to the muscles in the neighbourhood. The *lateral spinal branches* enter the spinal canal upon the cervical nerves, and have been described on p. 179.

The Vertebral Vein does not take origin within the cranium. It merely accompanies the vertebral artery in the cervical part of its course, and forms a close venous plexus around it as it proceeds through the succession of bony foramina in the transverse processes of the cervical vertebræ. Its radicles arise in the suboccipital region, where they anastomose with the tributaries of the occipital and deep cervical veins. Before it enters the transverse process of the atlas it receives a large offset from the intraspinal venous plexus. Inferiorly, the vertebral vein opens into the innominate vein (p. 238).

Dissection.—The muscles must now be completely removed in order that the vertebral and cranio-vertebral joints, and the ligaments in connection with the cervical portion of the spine may be examined. The axis, atlas, and occipital bone present a series of articulations in which the uniting apparatus is very different from that of the vertebræ below.

Articulations of the Lower Five Cervical Vertebræ.—The lower five cervical vertebræ are united together very much upon the same plan as the vertebræ in other regions of the vertebral column. Both the bodies and the neural arches are connected by distinct articulations and special ligaments.

Three separate joints may be said to exist between the opposed surfaces of the *bodies* of two adjacent vertebræ—viz., a central amphiarthrodial joint and two small lateral diarthrodial joints.

The *amphiarthrodial joint* (Fig. 249) occupies by far the

greatest part of the space which exists between the vertebral bodies, and it presents the usual characters of such an articulation. The opposed bony surfaces are coated by a thin layer of hyaline or encrusting cartilage, and are brought into direct union by an interposed disc of fibro-cartilage. The intervertebral discs are distinctly deeper in front than behind, and upon this the cervical curvature of the column in great measure depends.

The two *diarthrodial joints* are placed one on each side, where the disc of fibro-cartilage fails. They are of small extent, and are confined entirely to the intervals between

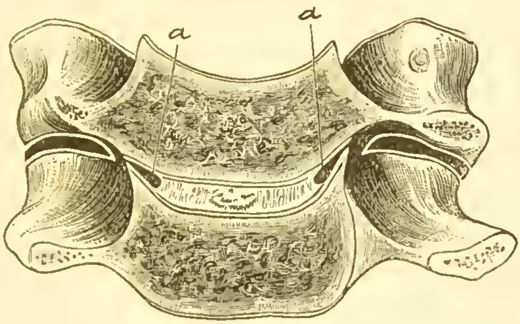

FIG. 249.—Coronal section through the bodies of two cervical vertebræ.

(*a a*) The two lateral diarthrodial joints between the bodies of two vertebræ.

the projecting lateral lips of the upper surface of the centrum, and the bevelled off lateral margins of the lower surface of the vertebral body immediately above. Here the bony surfaces are coated with encrusting cartilage, and are separated by a synovial cavity protected on the outer side by a feeble capsular ligament (Fig. 249, *a*, *a*).

The *ligaments* which bind the bodies of the five lower cervical vertebræ together are the direct continuation upwards of the anterior and the posterior common ligaments of the spine. In the removal of the spinal cord, the laminæ of the vertebræ below the axis have been taken away so that

very little dissection will be required to make out the connections of both of these ligaments. The *anterior common ligament* is a strong band placed in front of the vertebral bodies. It is more firmly fixed to the intervening intervertebral discs than to the bones. The *posterior common ligament* which lies on the posterior aspect of the vertebral bodies constitutes the anterior boundary of the spinal canal. In the cervical region it completely covers the bodies of the vertebræ, and does not present the denticulated appearance which is so characteristic of it lower down. It is chiefly attached to the cartilaginous discs and the adjacent margins of the bones.

The *neural arches* of the lower five cervical vertebræ are bound together by (*a*) the articulations between the articular processes; (*b*) ligamenta subflava; (*c*) by interspinous ligaments; and (*d*) intertransverse ligaments.

The *joints* between the opposing articular processes are of the diarthrodial variety. The surfaces of bone are coated with encrusting cartilage; there is a joint cavity lined by synovial membrane, and surrounded by a distinct capsular ligament. This ligament is more laxly arranged in the neck than in the lower regions of the spine.

The *ligamenta subflava* may be examined on the laminæ which were removed for the display of the spinal cord, and which the dissector was directed to retain. In this specimen they may be studied in the cervical, dorsal, and lumbar regions of the spine. They fill up the gaps between the laminæ of the vertebræ, and can be best seen when the fore aspect of the specimen is viewed. They are composed of yellow elastic tissue, and each ligament is attached superiorly to the anterior surface and inferior margin of the lamina of the vertebra above, whilst inferiorly it is fixed to the posterior surface and superior margin of the lamina of the vertebra next below. In this way they form with the laminæ a smooth, even posterior wall for the spinal canal. Each ligament extends from the posterior part of the articular

processes to the mesial plane, where it is in contact by a free thickened inner border with its neighbour of the opposite side. The mesial slit between them in each interneural space is filled by some lax connective tissue, and it allows the egress from the spinal canal of some small veins. The width of the ligaments in the different regions of the spine depends upon the size of the spinal canal. Thus they are widest in the neck and in the lumbar part of the column. The ligamenta subflava, by virtue of their great strength and elasticity, are powerful agents in maintaining the curvatures of the spine; they are also a valuable aid to the muscles in restoring the spine to its original position after it has been bent in a forward direction.

The *interspinous ligaments* are most strongly developed in the lumbar regions, where they fill up the intervals between the adjacent margins of contiguous spinous processes. In the dorsal region, and more especially in the neck, they are very weak.

The *supraspinous ligaments* are thickened bands which connect the summits of the spinous processes. In the neck they are replaced by the ligamentum nuchæ (p. 153).

The *intertransverse ligaments* are feebly marked in the cervical region, and extend chiefly between the anterior bars of the transverse processes.

Articulations of the Axis, Atlas, and Occipital Bone.—The articulations which exist between these three bones all belong to the diarthrodial class. Between the atlas and axis there are three such joints—viz., a pair between the opposed articular processes, and a third between the anterior face of the odontoid process and the posterior face of the anterior arch of the atlas. Between the atlas and occipital bone there are a pair of joints—viz., between the occipital condyles above and the elliptical cavities upon the upper aspect of the lateral masses of the atlas.

The ligaments connecting these three bones together may be divided into three main groups as follows:—

Ligaments connecting atlas with axis, . . .	Anterior atlanto-axial. Posterior atlanto-axial. Capsular. Transverse portion of the cruciform ligament. Accessory ligaments of the atlanto-axial joints.
Ligaments connecting occipital bone with atlas, .	Anterior occipito-atlantal. Posterior occipito-atlantal. Capsular.
Ligaments connecting occipital bone with axis, ...	Posterior occipito-axial. Appendices superior and inferior of the cruciform ligament. Alar odontoid or check. Suspensory.

The ligaments which are placed in relation to the exterior of the vertebræ should first be examined. These are the anterior and posterior atlanto-axial, and the anterior and posterior atlanto-occipital. The four capsular ligaments may also be more or less satisfactorily studied at the same time.

The Anterior Atlanto-axial Ligament (Fig. 250, 11) may be regarded as being to a certain extent a continuation upwards of the anterior common ligament of the spine. Below it is attached to the fore aspect of the body of the axis, whilst above it is fixed to the anterior arch of the atlas. It is thick and strong in the middle, but thins off towards the sides.

The Posterior Atlanto-axial Ligament fills up the interval between the laminæ of the axis vertebra and the posterior arch of the atlas, to the contiguous margins of which it is attached. It is broad and membranous, and is the representative, as its attachments show, of the ligamenta subflava. It is pierced on each side by the second cervical nerve as this passes backwards over the neural arch of the axis.

The Atlanto-axial Capsular Ligaments can be examined from the outside. They are somewhat lax, and on remov-

ing the outer part of each, the joint cavities will be opened into (Fig. 251).

The Anterior Atlanto-Occipital Ligament (Fig. 250, 6) extends from the upper border of the anterior arch of the atlas to the under surface of the basilar process of the occipital bone in front of the foramen magnum. On each side of the mesial plane it is thin and membranous, and

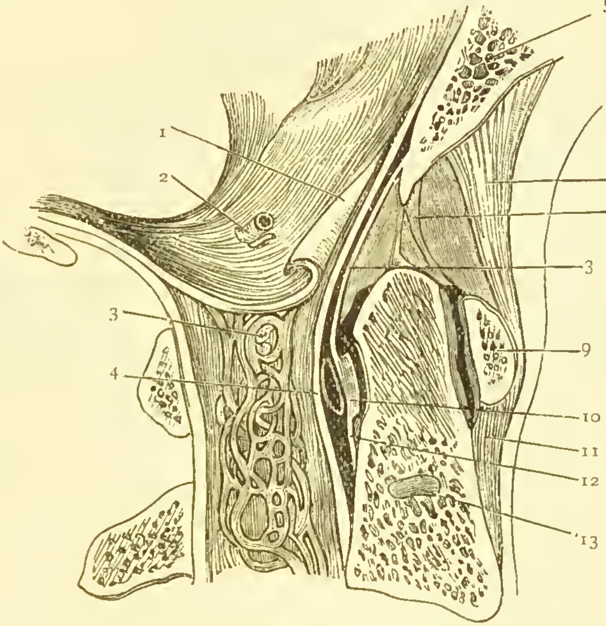

FIG. 250.—Mesial section through the basilar process of occipital bone, the atlas and the axis.—(From LUSCHKA, slightly modified.)

1. Dura mater.
2. Vertebral artery and first cervical nerve.
3. Second cervical nerve.
4. Posterior occipito-axial ligament.
5. Basilar process of occipital bone.
6. Anterior atlanto-occipital ligament.
7. Two parts of the suspensory odontoid ligament.
8. Appendix superior.
9. Anterior arch of atlas.
10. Transverse ligament.
11. Anterior atlanto-axial ligament.
12. Appendix inferior.
13. Lenticular disc of cartilage between the body of the axis and the odontoid process.

Between the posterior occipito-axial ligament and the transverse ligament a small synovial bursa may be seen.

stretches outwards so as to abut against the capsular ligament. In the middle line there is an exceedingly strong cord-like band, which stands out in strong relief from the rest of the ligament, and is carried downwards to the anterior tubercle of the atlas. Part of its fibres are attached to this, but a certain proportion become continuous with the central thickening of the anterior atlanto-axial ligament, and through this, with the anterior common ligament of the spine.

The Posterior Atlanto-Occipital Ligament is a thin and weak membrane which occupies the wide gap between the posterior arch of the atlas and the posterior border of the foramen magnum, to both of which it is attached. It is very firmly connected with the dura mater, and is so feebly developed that it is a matter of some difficulty to show it as a distinct layer after the latter has been removed. On each side it reaches the capsular ligament. Over each of the grooves on the posterior arch of the atlas for the vertebral arteries it is deficient ; here its lower border forms an arch, under which the vessel and the first cervical nerve pass. It is not uncommon to find this fibrous arch ossified.

The Atlanto-Occipital Capsular Ligaments (Fig. 251, 1) connect the occipital condyles with the lateral masses of the atlas. They completely surround the joints, and are connected in front with the anterior atlanto-occipital ligament, and behind with the posterior atlanto-occipital ligament.

The occipital bone, therefore, round the foramen magnum is attached by special ligaments to each of the four portions of the atlas—viz., to the anterior arch, to the two lateral masses, and to the posterior arch.

Dissection.—The remaining ligaments are placed within the spinal canal in connection with its anterior wall. For their proper display it is therefore necessary to remove with the bone-pliers the laminæ of the axis, and the posterior arch of the atlas. The tabular part of the occipital bone must, likewise, be taken away by sawing it through, on each side, immediately behind the jugular eminence and the condyle, and carrying the saw into the foramen magnum. The upper part of the

tube of dura mater which still remains in the spinal canal must next be carefully detached. A broad membranous band stretching upwards over the posterior aspect of the body and odontoid process of the axis is displayed. This is the posterior occipito-axial ligament.

The Posterior Occipito-axial Ligament (membrana tectoria) (Fig. 250, 4; and Fig. 251, 4 and 5) is a broad

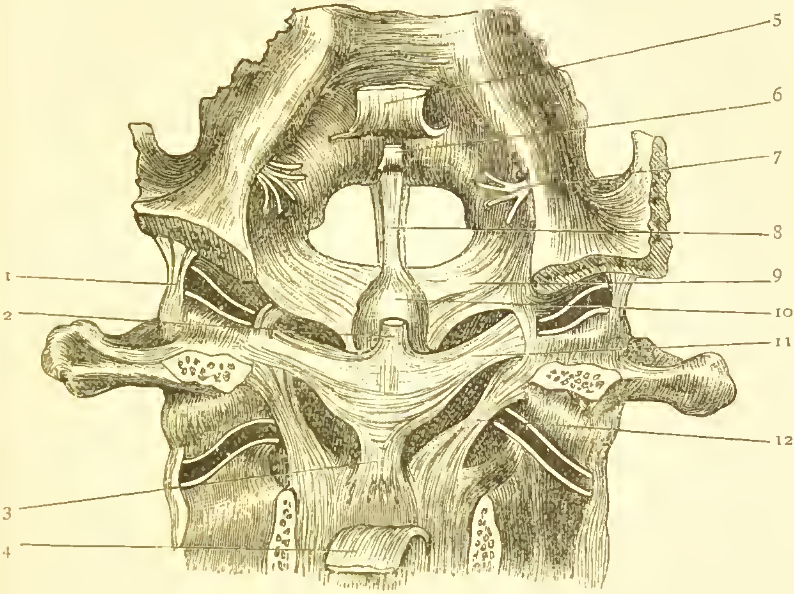

FIG. 251.—Ligaments on the anterior wall of the spinal canal which connect the occipital bone, the atlas, and axis. The posterior occipito-axial ligament and the superior appendix of the cruciform ligament have been partially removed, their attached extremities being alone left in position (From LUSCHKA, slightly modified.)

1. Portion of the atlanto-occipital capsular ligament.
2. Appendix superior of the cruciform ligament cut across.
3. Appendix inferior of the cruciform ligament.
4. Lower part of posterior occipito-axial ligament thrown downwards.
5. Upper part of the posterior occipito-axial ligament thrown upwards.
6. Upper attachment of appendix superior.
7. Hypoglossal nerve.
8. Two parts of the suspensory odontoid ligament.
9. Alar or check ligament.
10. Odontoid process.
11. Transverse ligament.
12. Accessory atlanto-axial ligament.

ligamentous sheet which is attached below to the posterior aspect of the body of the axis vertebra, where it is continuous with the posterior common ligament of the spine. It extends upwards, covering completely the odontoid process and the anterior margin of the foramen magnum, and is attached above to the posterior grooved surface of the basilar process of the occipital bone.

Dissection.—Detach this ligament from the axis and throw it upwards upon the basilar process. By this proceeding the accessory ligaments of the atlanto-axial joints and the cruciform ligament are brought into view, and very little further dissection is required to define them.

The Accessory Atlanto-axial Ligaments (Fig. 251, 12) (ligamenta lateralia inferiora) are two strong bands which take origin from the posterior aspect of the body of the axis vertebra close to the base of the odontoid process. Each band passes upwards and outwards, and is attached to the inner and hinder part of the lateral mass of the atlas. To a certain extent they assist the odontoid check ligaments in limiting the rotatory movements of the atlas upon the axis.

The Cruciform Ligament (ligamentum cruciatum) (Fig. 251) is composed of a transverse and a vertical part. The *transverse ligament* (ligamentum transversum atlantis) is by far the most important constituent of this apparatus (Fig. 250, 10; Fig. 251, 11; and Fig. 252, 4). It is a strong band which stretches from the tubercle on the inner aspect of the lateral mass of the atlas to the corresponding tubercle on the opposite side. With the anterior arch of the atlas it forms a ring which encloses the odontoid process—the pivot around which the atlas bearing the head turns. It is separated from the posterior aspect of the odontoid process by a loose synovial membrane which extends forward on each side until it almost reaches the synovial membrane in connection with the mesial joint between the odontoid process and the anterior arch of the atlas (Fig. 252, 2 and 3). Indeed in some cases a communication exists between the two synovial cavities.

The *vertical part* of the cruciform ligament consists of an upper and a lower limb, which are termed the appendices or crura. Both are attached to the dorsal surface of the transverse ligament. The *crus superius* is the longer and flatter of the two, and extends upwards on the posterior aspect of the head of the odontoid process to be attached to the posterior aspect of the basilar process immediately beyond the anterior margin of the foramen magnum (Fig. 250, 8; and Fig. 251, 2 and 6). The *crus inferius*, very much shorter,

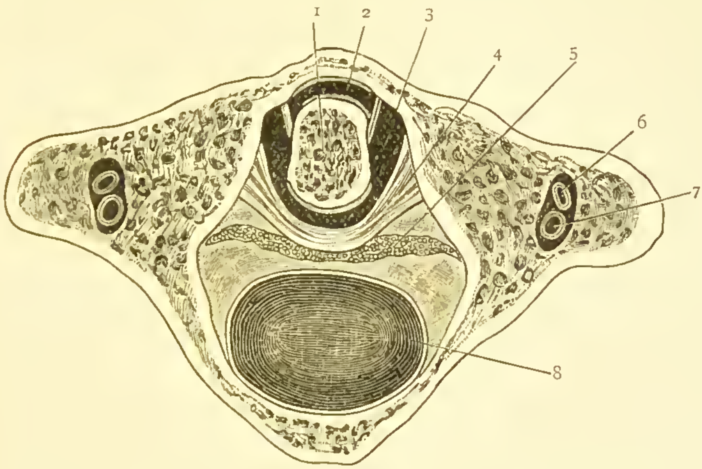

FIG. 252.—Transverse section through the atlas and odontoid process. (From CRUVEILHIER, slightly modified.)

1. Odontoid process.
2. Synovial cavity between the odontoid process and anterior arch of atlas.
3. Synovial cavity between the odontoid process and the transverse ligament.
4. Transverse ligament.
5. Posterior occipito-axial ligament.
6. Vertebral vein.
7. Vertebral artery.
8. Tube of dura mater.

extends downwards, and is fixed to the posterior aspect of the body of the axis vertebra (Fig. 250, 12; and Fig. 251, 3).

Dissection.—Detach the appendix superior from the basilar process, and throw it downwards. The suspensory ligament is thus displayed, and a better view of the alar or check ligaments obtained.

The Suspensory Ligament (ligamentum apicis dentis) (Fig. 250, 7; and Fig. 251, 8) of the odontoid consists of

two parts—an anterior and a posterior. The *posterior part* is a rounded cord-like ligament which is attached below to the summit of the odontoid process, and above to the fore margin of the foramen magnum. This ligament, inasmuch as it is developed around the continuation of the chorda dorsalis from the odontoid to the basis cranii, is a structure of considerable morphological interest. The *anterior part* of the suspensory ligament is a flat and weak band which is attached above to the anterior margin of the foramen magnum at the same point as the posterior portion. Below, the two portions are separated by an interval filled with cellular tissue, and the anterior part is attached to the odontoid process immediately above its articular facet for the anterior arch of the atlas.

The Alar or Check Ligaments (ligamenta alaria) (Fig. 251, 9) are very powerful bands which spring, one from each side of the summit of the odontoid process, and proceed outwards and slightly upwards to be attached to the inner aspect of the condyloid eminences of the occipital bone. They limit rotation of the head, and in this they are aided by the accessory atlanto-axial ligaments.

Movements.—Nodding movements of the head are permitted at the occipito-atlantal articulations. Rotatory movements of the head and atlas around the odontoid process, which acts as a pivot, take place at the atlanto-axial joints. Excessive rotation is checked by the alar or check ligaments.

MOUTH AND PHARYNX.

The dissector must now return to the anterior part of the skull which had been laid aside while the dissection of the prevertebral region was going on. The mouth and pharynx should, in the first instance, engage his attention.

Mouth.—The mouth is the entrance to or the vestibule of the alimentary canal. It is placed below the nasal chambers, in the lower part of the face, and its cavity is controlled by muscles which are under the influence of the will. The

mouth consists of two sub-divisions, viz., a smaller anterior part which is bounded in front by the lips and cheeks, and behind by the teeth and gums, and a large part, the mouth proper, which is placed within the teeth. The mucous lining of the mouth should be thoroughly cleansed, and the two sub-divisions of the cavity examined from the front through the oral fissure.

The *anterior part* of the mouth which passes round the teeth and gums is a mere fissure except when the cheeks are inflated with air. It is into this subdivision of the mouth that the parotid duct opens (p. 268). *Above* and *below* it is bounded by the reflection of the mucous membrane from the lips and cheeks on to the alveolar margins of the maxillary and mandibular bones. In *front* it opens upon the face by means of the oral fissure, whilst *posteriorly*, behind the last molar tooth, it communicates on each side by means of a distinct aperture with the cavity of the mouth proper. When all the teeth are in place the existence of this communication is of importance in cases of spasmodic closure of the jaws, because through it fluids may be introduced into the posterior part of the buccal cavity.

The *mouth proper* is that part of the buccal cavity which is placed within the teeth. It is bounded in front and laterally by the gums and teeth, whilst behind it communicates by means of the *isthmus faucium* with the pharynx (Fig. 253). The *floor* is formed by the tongue and the mucous membrane which stretches to this from the inner aspect of the mandible; the *roof* is vaulted, and is composed of the hard and soft palate (Fig. 253). When the mouth is closed the dorsum of the tongue is applied to the roof, and the cavity is almost completely obliterated. Into this part of the buccal cavity the ducts of the submaxillary glands (Wharton's ducts) and some of the ducts of the sublingual glands (ducts of Rivini) open (pp. 326 and 328).

The various parts which bound the oral cavity may now be examined in turn.

Lips.—The structure of the lips has in a great measure been already examined in the dissection of the face (p. 277). Each lip may be regarded as being composed of four layers. From before backwards these are—(1) cutaneous; (2) muscular; (3) glandular; and (4) mucous. The *skin* and *mucous membrane* become continuous with each other at

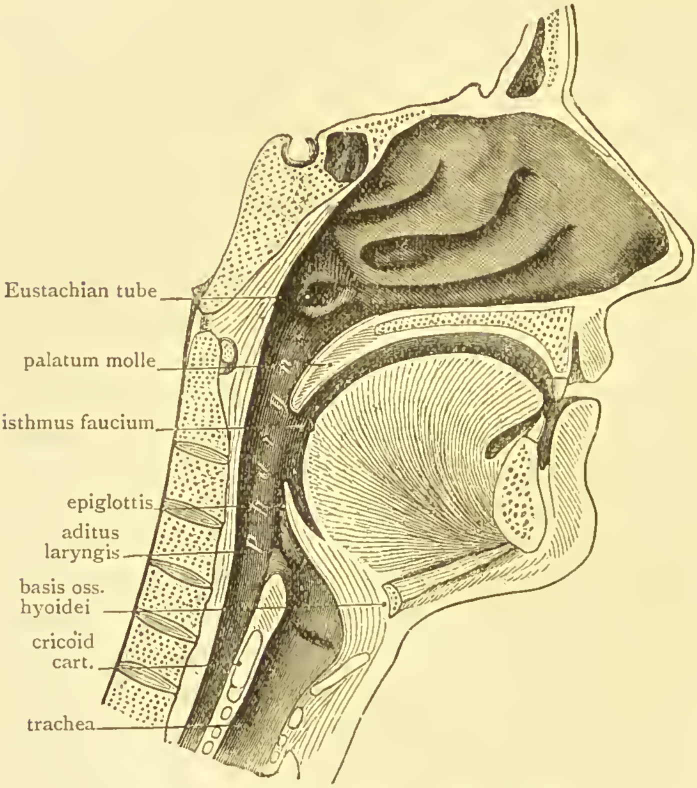

FIG. 253.—Mesial section through the nose, mouth, pharynx, and larynx. (From GEGENBAUR.)

the free margin of the lip. From the deep aspect of each lip the mucous membrane is reflected on to the alveolar margin of the corresponding jaw, and in the mesial plane it is raised in the form of a free fold. These folds are termed the *frænula;* in the dissection of the face they have been

more or less destroyed. The *muscular layer* constitutes the chief bulk of the lips. It is formed by the orbicularis oris and the various muscles which converge upon the mouth. The *labial glands* are very numerous and lie between the mucous membrane and the muscular fibres. In each lip there is an arterial arch formed by the corresponding coronary arteries (p. 290).

The Cheeks have five layers entering into their construction, all of which have been examined in the dissection of the face. They are—(1) skin; (2) a fatty layer traversed by some of the facial muscles and the facial artery; (3) the buccal aponeurosis; (4) the buccinator muscle; (5) the mucous membrane. The *buccal glands* are numerous and are situated between the buccinator muscle and the buccal aponeurosis. Their ducts pierce the muscle and open upon the inner aspect of the mucous membrane. The *buccal aponeurosis* is a dense fascia which covers the buccinator muscle. Above and below it is attached to the alveolar portions of the maxillary and mandibular bones, whilst behind it is continued backwards upon the side of the pharynx. The muscles which traverse the *fatty layer* are chiefly the zygomaticus major, the risorius, and the posterior fibres of the platysma. The parotid duct pierces the three inner layers of the cheek, and opens into the mouth opposite the second molar tooth of the upper jaw.

Gums and Teeth.—The mucous membrane of the gums is smooth, vascular, and firmly bound down to the subjacent periosteum of the alveolar portions of the jaws by a stratum of dense connective tissue. It is continuous on the one hand with the mucous membrane of the lips and cheeks, and on the other, with the mucous membrane of the floor of the mouth. The gum embraces closely the neck of each tooth.

In the adult the teeth in each jaw number sixteen. From the middle line backwards, on each side, they are the two incisors, the canine, the two bicuspids, the three molars.

Floor of the Mouth.—The mucous membrane is reflected from the inner aspect of the lower jaw, on to the side of the tongue, but in the fore part of the mouth the tongue lies free in the buccal cavity. Here the mucous membrane stretches across the floor from one side of the lower jaw to the other (Fig. 238, p. 237). On each side of this region the projection formed by the sublingual gland can be distinguished. Further, if the tongue be pulled upwards, a mesial fold of mucous membrane will be seen to connect its under surface to the floor. This is the *frænum linguæ.* The dissector must also look for the openings of Wharton's ducts. Each terminates in a papillary orifice placed close to the side of the frænum. Farther back, between the side of the tongue and the jaw, are the openings of the ducts of Rivini.

Roof of the Mouth.—The hard and the soft palate form the continuous concave and vaulted roof of the mouth (Fig. 253). Projecting from the middle of the posterior free margin of the soft palate, and resting upon the dorsum of the tongue, will be seen the *uvula* (Fig. 254). The palate both hard and soft is traversed by a median ridge or raphe which terminates in front, opposite the anterior palatine foramen, in a slight elevation or papilla. In the anterior part of the hard palate the mucous membrane on each side of the raphe is thrown into three or four transverse hard corrugations or ridges; behind this it is comparatively smooth.

Isthmus Faucium.—This is the name which is given to the communication between the buccal cavity and the pharynx (Fig. 254). To obtain a good view of it from the front, the mouth must be well opened and the tongue depressed.[1] It is bounded above by the soft palate, below by the dorsum of the tongue, and on each side by two curved folds of mucous membrane, termed respectively the anterior and the posterior pillars of the fauces.

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[1] The isthmus faucium and the parts which bound it can best be examined in the living subject (Fig. 254).

The *pillars of the fauces* spring from the base of the uvula, and arch outwards and then downwards. The *anterior pillar* as it descends inclines forwards, and ends upon the side of the posterior part of the tongue ; the *posterior pillar*, more strongly marked, inclines backwards, and is lost upon the side of the pharynx. The former encloses the palato-glossus muscle, the latter the palato-pharyngeus muscle.

In the triangular interval which is formed by the divergence of these two folds will be observed the *tonsil.*

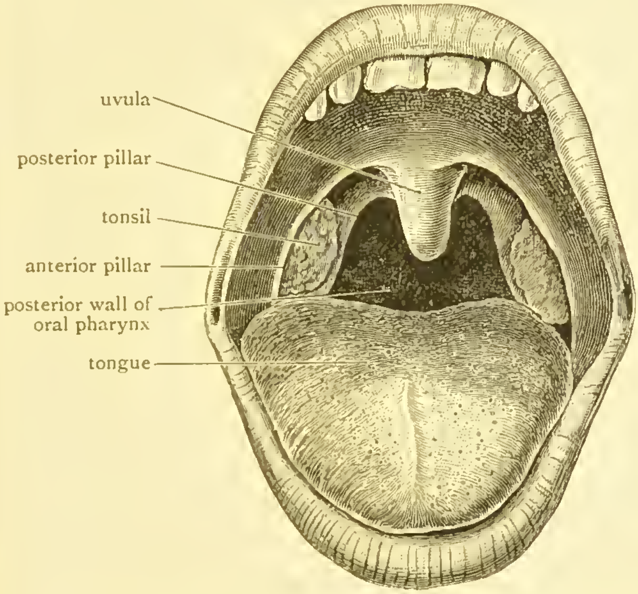

FIG. 254.—Isthmus of the fauces as seen through the widely opened mouth. The tonsils in the individual from which this drawing was taken were somewhat enlarged.

Pharynx.—The pharynx is a wide musculo-aponeurotic canal $4\frac{1}{2}$ inches long, which extends from the base of the cranium to the level of the body of the sixth cervical vertebra. Here at the lower border of the cricoid cartilage it becomes continuous with the œsophagus. Placed behind the nasal cavities, the mouth and the larynx, it serves as the

passage which conducts air to and from the larynx, as well as the food from the mouth to the œsophagus.

To obtain a proper idea of the connections of the pharynx, the dissector should moderately distend its walls by stuffing it with tow. This may be introduced either from above, through the mouth, or from below, through the œsophagus.

The pharynx will now present a somewhat ovoid form. It is widest opposite the hyoid bone; from this upwards it narrows slightly as it ascends to the basis cranii. When traced in an opposite direction its width diminishes rapidly and uniformly, until it gives place to the œsophagus. Posteriorly its wall is complete, and when in position rests upon the upper five cervical vertebræ, the prevertebral muscles, and the prevertebral fascia. To these it is bound by some lax connective tissue which offers no barrier to the movements of the canal during the process of deglutition. *Laterally*, the pharynx is related to the great vessels and nerves of the neck as well as to the styloid process and the muscles which take origin from it. Upon this aspect of the pharynx also is placed the pharyngeal plexus of nerves, which supplies its walls with motor and sensory twigs. *In front* the pharyngeal wall is interrupted by the openings of the nasal chambers, mouth, and larynx, and it is to the structures which lie in proximity to these apertures that it derives its principal attachment. Thus from above downwards it is fixed—(*a*) to the internal pterygoid plate; (*b*) to the pterygo-maxillary ligament; (*c*) to the side of the tongue; (*d*) to the inner aspect of the mandible; (*e*) to the hyoid bone; (*f*) to the thyroid cartilage; (*g*) to the cricoid cartilage. *Above* it is attached to the basis cranii. These various attachments will be studied more fully when we dissect the constituents which enter into the construction of its wall.

It should be noted that a false idea of the natural form of the pharynx is obtained when it is examined in its present stuffed condition and apart from the vertebral column against which it rests. When seen in transverse sections of

the frozen body it will be observed that with the exception of its upper or nasal part, which remains patent under all conditions, the anterior wall is more or less nearly approximated to the posterior wall, and below the opening of the larynx it presents the appearance of a simple transverse slit.

Pharyngeal Wall.—The wall of the pharynx may be said to consist of three well-marked strata—viz., an external muscular, an intermediate aponeurotic, and an internal mucous. The muscular layer, which is composed of the three constrictor muscles, with the stylo-pharyngeus and palato-pharyngeus on each side, should first be dissected.

For this purpose, place the preparation so that the chin rests upon a block, and the pharynx hangs downwards with its posterior surface towards the dissector. The constrictor muscles should now be carefully cleaned in the direction of the muscular fibres, by removing the bucco-pharyngeal fascia which covers them.

Bucco-pharyngeal Fascia.—This coating is sometimes spoken of under the name of the *tunica pharyngis externa*, more frequently, however, it is called *the bucco-pharyngeal fascia*, seeing that it is continuous in front with the buccal aponeurosis. This fascial investment must not be confounded with the prevertebral layer of cervical fascia which forms a distinct lamina behind it. The bucco-pharyngeal and the prevertebral layers of fascia are separated from each other by an interval occupied by lax connective tissue, and which, from the ease with which fluids can travel within it, is called the *retro-pharyngeal space* (Fig. 238, p. 237). Both layers of fascia are connected laterally with the carotid sheath.

Pharyngeal Veins.—Upon the posterior and lateral walls of the pharynx the dissector will not fail to notice numerous veins joined together in a plexiform manner. These constitute the *pharyngeal venous plexus*, which collects blood from the pharynx, soft palate, and prevertebral region, and communicates with the pterygoid plexus. Two or more channels lead the blood from it to the internal jugular vein (p. 338). This venous plexus, together with the pharyngeal

plexus of nerves, will require to be removed in order to display the muscles properly.

Constrictor Muscles.—The constrictor muscles are three flat sheets of muscular fibres which are so arranged that they overlap each other from below upwards; thus the inferior constrictor overlaps the lower part of the middle constrictor, whilst the middle constrictor in turn overlaps the lower part of the superior constrictor. The three muscles are inserted in the mesial plane into a median raphe, which descends from the basilar process of the occipital bone along the posterior aspect of the pharynx.

The *inferior constrictor* (Fig. 255, *f*) is narrow in front at its origin, but it spreads out as it passes backwards towards its insertion. It arises by two heads; of these the *lower* springs from the posterior part of the side of the cricoid cartilage, whilst the *upper* and larger head takes origin from the inferior cornu, the oblique line of the ala, and the upper border of the thyroid cartilage. The muscle curves backwards round the pharyngeal wall to meet its fellow of the opposite side in the median raphe. The lower fibres take a horizontal direction, but the remainder ascend with increasing degrees of obliquity, until the highest fibres reach the raphe at a point a short distance below the basis cranii. The lower margin of the inferior constrictor overlaps the commencement of the œsophagus, and passing upwards under cover of it, so as to reach the larynx, will be seen the recurrent laryngeal nerve and the laryngeal branch of the inferior thyroid artery (Fig. 255, 5).

The *middle constrictor* (Fig. 255, *e*) is a fan-shaped muscle. Narrow, and pointed in front, it arises from the great and small cornua of the hyoid bone as well as from the stylo-hyoid ligament. From this its fibres radiate widely, and pass round the pharyngeal wall, to be inserted with the corresponding fibres of the opposite side into the median raphe. The lower portion of this muscle is overlapped by the inferior constrictor, and in the interval which separates

the margins of the two muscles in front, the internal laryngeal nerve and the laryngeal branch of the superior thyroid artery will be seen piercing the thyro-hyoid membrane to gain the interior of the larynx (Fig. 255, 2 and 3).

a. Buccinator.
b. Tensor palati.
c. Levator palati.
d. Superior constrictor.
e. Middle constrictor.
f. Inferior constrictor.
g. Thyro-hyoid.
h. Hyo-glossus.
k. Stylo-hyoid.
l. Mylo-hyoid.
m. Crico-thyroid.
n. Stylo-pharyngeus.
o. Stylo-glossus.
p. Stylo-hyoid ligament.
q. Pterygo-maxillary ligament.
1. Glosso-pharyngeal nerve.
2. Superior laryngeal artery.
3. Superior laryngeal nerve.
4. External laryngeal nerve.
5. Inferior laryngeal nerve and artery.

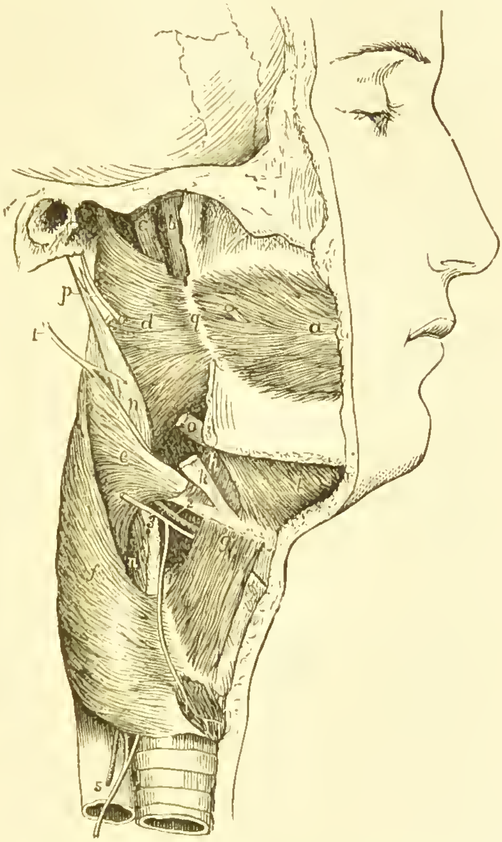

FIG. 255.—Profile view of the pharynx to show the constrictor muscles. (From TURNER.)

Dissection.—The superior constrictor possesses a somewhat complicated origin, and to bring this fully into view, it will be necessary to cut through the internal pterygoid muscle about its middle, and turn the upper and lower portions aside. In doing this, be careful of the small tensor palati muscle which lies immediately subjacent to the internal pterygoid.

The *superior constrictor* (Fig. 255, *d*) has a weak but continuous line of origin from the following parts—viz. (*a*) the lower third of the posterior border of the internal pterygoid plate, and the hamular process; (*b*) the pterygo-maxillary ligament which is common to it, and the buccinator muscle; (*c*) the posterior end of the mylo-hyoid ridge on the inner aspect of the mandible; (*d*) the mucous membrane of the mouth, and side of the tongue. From this somewhat extensive origin, the fibres curve backwards to reach the mesial raphe, whilst, as a rule, some of the highest gain a distinct insertion into the pharyngeal tubercle, on the under surface of the basi-occipital bone.

The lower part of the superior constrictor is overlapped by the middle constrictor, and in the interval between the two muscles will be seen the stylo-pharyngeus as it passes downwards under cover of the middle constrictor (Fig. 255, *n*). In the same interval will be seen the glosso-pharyngeal nerve. The upper border of the muscle is free and crescentic, and it falls short of the basis cranii.

The Pterygo-maxillary Ligament (Fig. 255, *q*) can now be studied. It is a strong, narrow, tendinous band, which extends from the hamular process of the internal pterygoid plate, to the posterior part of the mylo-hyoid ridge of the mandible. It acts as a tendinous bond of union between the buccinator and superior constrictor muscles, and its connections can be best appreciated by introducing the finger into the mouth and pressing outwards along its course.

Sinus of Morgagni.—This is the name which is applied to the semilunar space which intervenes between the upper crescentic margin of the superior constrictor and the basis cranii. The deficiency in the muscular wall of the pharynx at this point is compensated for by the increased strength of the pharyngeal aponeurosis. In contact with the outer surface of the aponeurosis, a little dissection will display two muscles belonging to the soft palate—viz., the *levator*

palati, and the *tensor palati* (Fig. 255, *c* and *b*). The levator is rounded and fleshy, and lies behind the tensor, which is flatter and more tendinous. The latter can readily be recognised, from its position in relation to the deep surface of the internal pterygoid muscle, and from its tendon winding inwards under the hamular process. In the upper part of the space, close to the basis cranii, and in intimate relationship to the origin of the two muscles, will be seen the *Eustachian tube.*

Pharyngeal Aponeurosis.—The pharyngeal aponeurosis is strongly marked in its upper part, and maintains the integrity of the wall of the pharynx where the muscular fibres are absent. As it is traced downwards it gradually becomes weaker, until it is ultimately lost as a distinct layer. It lies between the muscles and mucous membrane, and only comes to the surface where the muscles are absent. It is the principal means by which the pharynx is attached to the base of the skull. Thus it is fixed to the basilar process of the occipital bone, to the apex of the petrous bone, and also to the cartilage which intervenes between these bones.

Dissection.—The pharynx should now be opened by a vertical and mesial incision through the entire length of the posterior wall. At the upper extremity of this cut, the knife should be carried transversely outwards, close to the basis cranii, so as to divide the attachment of the posterior wall to the basi-occipital bone. The stuffing should be removed, and the mucous surface of the pharynx cleansed.

Interior of the Pharynx.—The *roof* of the pharynx will be seen to be formed by the basilar process of the occipital bone, covered by a dense periosteum, and a thick coating of mucous membrane. It is important to note that the posterior wall and the roof of the pharynx can be explored by the finger introduced through the mouth.

The *mucous membrane*, or innermost stratum which enters into the construction of the pharyngeal wall, is now exposed, and the dissector will note that it is continuous through the

various apertures with the mucous membrane of the nasal fossæ, of the Eustachian tubes, of the buccal cavity, of the larynx, and of the œsophagus.

The *glands* in connection with the mucous membrane of the pharynx are of two kinds—viz., racemose and follicular. The *racemose glands* will be noticed to form a thick layer on the lateral and posterior aspects of the upper part of the pharyngeal wall. They gradually diminish in number as they are followed downwards, and opposite the isthmus faucium they are separated from each other by considerable intervals. The *follicular glands* are similar in character to those which are observed on the root of the tongue, and to those which constitute the tonsils. In some localities they occur in an isolated condition, in others they are collected together in masses of different sizes. One aggregation of considerable size is placed upon the upper part of the posterior wall of the pharynx, where this joins the roof. It is termed the *pharyngeal tonsil* (Luschka), and is of some clinical importance. It is oval in form, and about half-an inch in length (Fig. 256).

The soft palate which hangs like a curtain over the isthmus faucium may be regarded as dividing the pharynx into an upper and a lower part. The *upper portion* or *naso-pharynx* (cavum pharyngo-nasale) is placed behind the nasal fossæ and remains always patent (Fig. 256). It presents four apertures through which it is brought into connection with the nasal chambers and the tympanic cavities—viz., the two choanæ or posterior nares, and the mouths of the two Eustachian tubes.

The *posterior nares* or *choanæ* are two large oval openings, placed immediately below the base of the skull, which look directly backwards into the naso-pharynx. They constitute the communication between the nasal fossæ and the pharynx, and are separated from each other by the thin posterior border of the vomer bone. The vertical diameter of each opening measures about one inch, whilst the

transverse diameter at the widest part is about half-an-inch. By looking through the posterior nares the dissector obtains a partial view of the two lower meatuses of the nose, and of the posterior extremities of the middle and inferior turbinated bones.

The orifices of the *Eustachian tubes* are placed one on each lateral wall of the naso-pharynx, behind the lower part

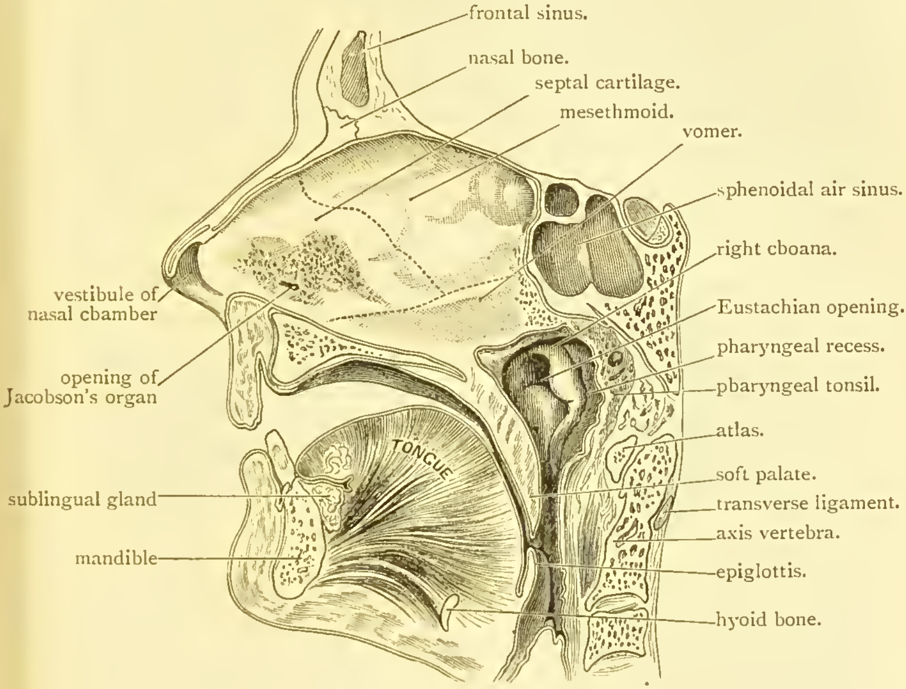

FIG. 256.—Antero-posterior section through the nose, mouth, and pharynx, a little to the left of the mesial plane.

of the posterior nares. The level at which these apertures lie may be said to correspond closely with that of the posterior extremities of the inferior turbinated bones. The orifice of the Eustachian tube is bounded above and on the posterior side by a high rounded prominent margin, which is altogether deficient below and in front—a condition of affairs which favours very materially the passage of the

Eustachian catheter.[1] In the natural condition of parts there is a narrow deep recess or slit on the lateral wall of the naso-pharynx behind the prominent posterior lip of the Eustachian orifice. This is termed the *recessus infundibuliformis* or *recessus pharyngis*, and it possesses considerable interest from a developmental point of view (Fig. 256).

When the naso-pharynx is illuminated by a mirror introduced through the mouth, a view of the four orifices which open into this part of the pharynx may be obtained. Owing to the mirror being placed obliquely and below the level of the hard palate, only the hinder parts of the inferior turbinated bones are visible through the choanæ, and the inferior meatus of the nose is altogether out of sight. The middle and superior meatus of the nose, and the middle and superior turbinated bones, however, can be brought into view and their condition ascertained. The lateral wall of the naso-pharynx and the Eustachian orifice can also be fully inspected.

Below the soft palate there are three mesial openings into the pharynx—viz., the opening of the fauces, the opening of the larynx, and the opening into the œsophagus. The part of the pharynx which lies behind the cavity of the mouth is sometimes called the *oral pharynx* (cavum pharyngo-orale), whilst that part which is placed behind the hyoid bone and larynx is termed the *laryngo-pharynx* (cavum pharyngo-laryngeum).

The *isthmus faucium* has already been studied from the front, and its boundaries have been described. It should now be carefully examined from behind, and the dissector should notice how greatly the size of the aperture varies with differences in the position of the soft palate (p. 401). The lumen of the portion of the pharynx which lies behind the isthmus faucium (oral pharynx), is greatly influenced by the position of the tongue.

The *laryngeal opening* is placed below the isthmus

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[1] An Eustachian catheter can be very readily improvised by bending the extremity of an ordinary blowpipe. The dissector is recommended to practise the passage of this instrument into the Eustachian tube through the nose.

faucium. It is a large obliquely placed aperture, which slopes from above downwards and backwards. Somewhat triangular in form, it is broadest in front, where it is bounded by the uprightly placed *epiglottis*. Behind it is narrow, and ends in the interval between the two *arytenoid cartilages*; on either side stretches a sharp fold of mucous membrane, called the *aryteno-epiglottidean fold*.

On either side of the posterior part of the laryngeal opening, between the arytenoid cartilage and the posterior part of the ala of the thyroid cartilage, there is a small downwardly directed recess, which presents a wide entrance but

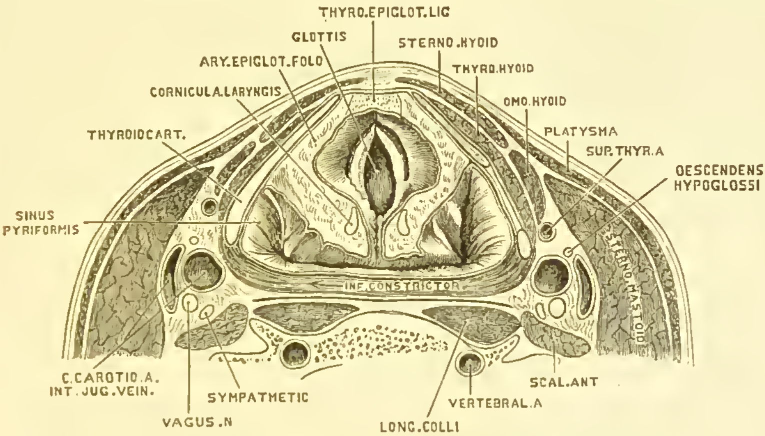

FIG. 257.—Transverse section through the neck at the level of the upper border of the thyroid cartilage.

rapidly narrows towards the bottom (Fig. 257). It is called the *sinus pyriformis*, and it is important to the surgeon because it is in this little pocket that foreign bodies introduced into the pharynx are most liable to be caught. Below the opening of the larynx, the anterior and posterior walls of the pharynx are always closely applied to each other, except during the passage of food.

The *œsophageal opening* is placed opposite the lower border of the cricoid cartilage. This is the narrowest part of the pharynx.

Soft Palate.—The soft palate is a movable curtain, which intervenes between the buccal cavity and the pharynx. During deglutition, however, it is raised so as to shut off the upper nasal part of the pharynx from the portion below, and at the same time open up the isthmus faucium. In *front* it is attached to the posterior margin of the hard palate; *laterally*, it is connected with the sides of the pharynx; whilst *posteriorly* it presents a free border. From the centre of this free margin the conical elevation termed the *uvula* projects. The upper surface of the soft palate is convex and continuous with the floor of the nasal fossæ; the inferior surface is concave and continuous with the vaulted roof of the mouth. Upon the latter surface may be seen a slightly marked mesial ridge or raphe.

The soft palate is composed of a fold of mucous membrane, between the two layers of which are interposed muscular, aponeurotic, and glandular structures, together with blood vessels and nerves.

Palatal muscles, .	The two levatores palati. The two tensores palati. The two palato-glossi. The two palato-pharyngei. The azygos uvulæ.
Palatal aponeurosis.	
Palatal glands.	
Arteries, .	Ascending palatine from facial. Palatine branch from ascending pharyngeal. Twigs from the descending palatine branch of the internal maxillary.
Nerves, . .	Small or posterior palatine, External palatine, . . — from the spheno-palatine ganglion.

Dissection.—The dissection of the soft palate is difficult, and it is only in a fresh part that the precise relations of the different muscular layers can be made out. Begin by rendering it tense by means of a hook, and then remove carefully the mucous membrane from its upper and lower surfaces, and also from the anterior and posterior pillars of the fauces. The latter proceeding will expose the palato-glossus and the palato-pharyngeus muscles on each side. The *palatine glands* will be chiefly found on the upper surface of the soft palate, and around the uvula.

The Palato-glossus (*constrictor isthmi faucium*) is a delicate muscular slip, which arises from the side of the posterior part of the tongue, and curves upwards and inwards to reach the under surface of the soft palate. Here its fibres spread out, and become continuous with the corresponding fasciculi of the opposite side. It forms the lowest muscular stratum of the soft palate.

The Palato-pharyngeus forms two muscular strata in the soft palate which enclose between them the azygos uvulæ and the levator palati muscles. The *upper layer* is very weak, and confined to the posterior part of the velum. It constitutes the most superficial muscular stratum on this aspect of the palate, and becomes continuous with the corresponding portion of the muscle of the opposite side. The *deeper layer* takes origin from the posterior margin of the palate bone and from the palatal aponeurosis, while some of its fibres mingle with those of the corresponding muscle of the opposite side. Outside the soft palate the two strata come together, and are joined by one or two delicate muscular slips which spring from the lower border of the cartilage of the Eustachian tube. These slips are sometimes described as the *salpingo-pharyngeus muscle.* The palato-pharyngeus thus formed arches downwards and backwards in the posterior pillar of the fauces to reach the stylo-pharyngeus with which it is inserted into the superior and posterior borders of the thyroid cartilage. Some of its fibres, however, incline backwards, and are inserted into the pharyngeal aponeurosis.

Azygos Uvulæ.—This delicate muscle is placed on the upper aspect of the soft palate, and posteriorly it is covered by the superficial fibres of the palato-pharyngeus. These must be removed to expose it fully. It consists of two minute slips which, as a rule, arise from the posterior nasal spine of the hard palate, and lie one on either side of the mesial plane. As they proceed backwards into the uvula they unite into a single rounded muscular belly.

Dissection.—The levator palati muscle has already been seen on the outer aspect of the pharynx in the sinus of Morgagni. To display it fully it is necessary to remove the wall of the pharynx between the Eustachian tube above, and the upper border of the superior constrictor below, and then follow its fibres into the soft palate. In a well-injected subject the dissector will observe the ascending palatine artery in relation to this muscle.

The Levator Palati is a rounded fleshy muscle which arises from the lower and inner border of the cartilage of the Eustachian tube, and from the rough surface on the under aspect of the apex of the petrous bone in front of the carotid canal. It passes downwards and forwards, crosses the upper border of the superior constrictor, and piercing the pharyngeal aponeurosis enters the soft palate. Here its fibres spread out below the azygos uvulæ and above the anterior or deep portion of the palato-pharyngeus. In front, some of the fibres are inserted into the palatal aponeurosis, but behind this, the larger proportion of the fibres become continuous with the corresponding fasciculi of the opposite side.

Tensor or Circumflexus Palati.—This little muscle lies in front of the levator palati. It is flat and band-like, and closely applied to the deep surface of the internal pterygoid muscle. It arises from the scaphoid fossa at the root of the internal pterygoid plate, from the spine of the sphenoid and from the outer aspect of the Eustachian tube. It descends perpendicularly and ends in a tendon which turns horizontally inwards under the hamular process. A synovial bursa facilitates the play of the tendon upon the bone. In the soft palate the tendon expands below the deep part of the palato-pharyngeus, and is inserted partly into the transverse ridge on the under surface of the horizontal plate of the palate bone, and partly into the palatal aponeurosis with which it blends.

Palatal Aponeurosis.—The palatal aponeurosis extends backwards from the posterior margin of the hard palate to give strength and support to the soft palate. At first it is strongly marked, but becomes gradually weaker as it ap-

proaches the free border of the soft palate. A portion of the deep fibres of the palato-pharyngeus, some of the fibres of the levator palati, and the tendon of the tensor palati obtain attachment to it.

Vessel and Nerves of the Soft Palate.—The *inferior or ascending palatine branch* of the facial is, as a rule, the principal artery of supply to the soft palate. It has already been traced to the outer wall of the pharynx (pp. 257 and 336). Here it is seen in the sinus of Morgagni, in relation to the levator palati muscle which it accompanies into the soft palate. The *palatine branch* of the ascending pharyngeal artery may also be traced into the soft palate. In cases where the preceding artery is small, this twig will be found enlarged so as to take its place (p. 336). The *descending palatine* branch of the internal maxillary artery likewise sends small twigs to the soft palate and tonsil.

Two nerves enter the soft palate from Meckel's ganglion—viz., the *external* and the *posterior palatine nerves.* It would appear, however, that they do not supply the muscles, but are distributed to the mucous membrane. The levator palati, the azygos uvulæ, the palato-glossus, and the palato-pharyngeus are supplied by twigs from the pharyngeal branches of the vagus, which convey to them fibres which are originally derived from the accessory part of the spinal accessory (*v.* p. 346) (W. Aldren Turner). The tensor palati is probably supplied by the branch which it receives from the otic ganglion, and which leads to it fibres which originally come from the motor part of the trigeminal nerve.

The Tonsils are two prominent rounded bodies, placed one on each side of the fauces immediately above the base of the tongue and between the two pillars of the soft palate. The *buccal* or *internal* surface of the tonsil is perforated by a number of orifices which lead into crypts or recesses in its substance: its *external* surface rests upon the superior constrictor muscle.

The tonsils have a rich blood supply. They derive arterial twigs from the tonsillar and inferior palatine branches of the facial, the descending palatine branch of

the internal maxillary, the ascending pharyngeal, and the dorsalis linguæ.

Eustachian Tube.—This is the canal which conveys air from the pharynx to the tympanic cavity. It is divided into two portions, according to the parts which enter into the construction of its walls. Thus, in the *outer part* of its course as it nears the tympanum, its walls are bony, and it runs in the interval between the squamous and petrous portions of the temporal bone. The *inner part* is placed on the base of the skull, and is lodged in the gutter or groove between the apex of the petrous part of the temporal bone and the great wing of the sphenoid. This is the subdivision of the tube which comes under the notice of the dissector at the present stage, and he should first note its direction and then study its relations and the construction of its walls.

The direction of the canal can be readily ascertained by passing a probe into it through its pharyngeal orifice. It will be seen to run backwards and outwards with a slight inclination upwards. At the same time it will be noticed to pass between the origin of the levator palati, which lies upon its inner side, and the origin of the tensor palati, which is placed upon its outer side. This relationship is best seen in coronal sections through the frozen head. The dissector should now proceed to remove the mucous membrane from around the pharyngeal orifice of the tube. This will reveal the fact that its wall is strengthened by a triangular plate of cartilage, which is folded upon itself so as to protect the tube on its upper and inner aspects. The cartilage is deficient below and externally, its place being taken by dense fibrous tissue, which connects the margins of the cartilage and completes the wall of the canal. This explains the characteristic form which its pharyngeal orifice presents (p. 409). A muscular slip, which descends from the outer margin of the cartilage in relation to the outer unprotected side of the tube, has been termed *the dilatator tubæ* (Rudinger). It joins the tensor palati. The interior of the tube is lined by mucous

membrane continuous with that of the pharynx, and it will be noticed that, as the tube is traced towards the pharynx, it gradually increases in calibre. Hence it is frequently described as trumpet-shaped.

CAROTID CANAL AND SUPERIOR MAXILLARY NERVE.

Dissection.—The carotid canal, which traverses the fore part of the petrous bone, may now be opened up by removing its inferior wall with the bone-pliers. In doing this, it is not necessary to interfere with the Eustachian tube, which lies in close proximity. It is well to preserve this structure until we undertake the dissection of the otic ganglion.

Carotid Canal.—The carotid canal contains the internal carotid artery and the stout ascending branch of the superior cervical ganglion of the sympathetic.

The *internal carotid artery* in this part of its course is about three-fourths of an inch long. At first it ascends vertically; then, bending suddenly, it runs horizontally forwards and inwards. It emerges from the canal at the apex of the petrous bone. From this point onwards the internal carotid artery has been already examined (p. 358). Whilst within the carotid canal it lies in front of the internal ear.

Ascending branch of the cervical sympathetic.—The dissector has already noted a large branch proceeding from the upper end of the superior cervical ganglion and entering the carotid canal with the internal carotid artery. This almost immediately divides into two parts, which place themselves one on either side of the artery, and supply branches to its coats. The further dissection of these branches is a matter of great difficulty, and can only be satisfactorily effected under specially favourable circumstances. The *external branch* breaks up into the *carotid plexus*; the *internal branch* is continued into the *cavernous plexus*. From these primary offshoots secondary plexuses are prolonged upon the various branches which spring from the internal carotid artery.

The *carotid plexus*, which lies upon the outer aspect of the internal carotid artery, gives off the following branches—(1) one or two filaments to the abducent or sixth nerve as it turns round the internal carotid artery; (2) one or two twigs which join the inner part of the Gasserian ganglion; (3) the large deep petrosal nerve; (4) the small carotico-tympanic nerve.

The *large deep petrosal nerve* runs to the posterior aspect of the body of the sphenoid, and at the entrance to the Vidian canal it joins the *great superficial petrosal nerve* and forms the *Vidian nerve* (p. 359).

The *carotico-tympanic branch* of the carotid plexus joins the tympanic branch of the glosso-pharyngeal as it traverses the tympanum (p. 342, and Fig. 240).

The carotid plexus also receives the *small deep petrosal nerve* from the tympanic branch of the glosso-pharyngeal.

The *cavernous plexus* has already been sufficiently described on p. 358.

Dissection to Expose the Superior Maxillary Nerve.—As the superior maxillary nerve proceeds forwards to reach the face, it traverses the upper part of the spheno-maxillary fossa and the infra-orbital canal. The dissector should therefore proceed to expose the nerve in these localities. Remove the temporal muscle and the upper head of the external pterygoid muscle, and, placing the saw upon the cut margin of the skull at a point immediately above the external auditory meatus, carry it obliquely downwards and forwards through the squamous part of the temporal bone and the great wing of the sphenoid towards the inner end of the sphenoidal fissure. This saw-cut should enter the sphenoidal fissure immediately to the outer side of the foramen rotundum. A second saw-cut should then be made from the cut-margin of the cranial wall, immediately above the anterior margin of the great wing of the sphenoid bone downwards into the sphenoidal fissure to meet the first saw-cut. The piece of bone included between these cuts can now be removed. Additional space may be obtained and the spheno-maxillary fossa more fully opened up by removing what remains of the great wing of the sphenoid upon the outer side of the foramen rotundum, but the circumference of this aperture must be carefully preserved. Proceed, in the next place, to open up the infra-orbital canal. In its posterior part its upper wall is usually so thin that it can easily be removed by one of the blades of a pair of forceps, but in front it sinks deeply under the rim of the orbital opening, and here the chisel must be employed. The superior maxillary nerve can now be defined and its branches displayed. The infra-orbital artery and vein, which accompany the nerve, will be exposed at the same time.

Superior Maxillary Nerve.—The superior maxillary nerve springs from the Gasserian ganglion within the cranial cavity (p. 355). It is composed entirely of sensory fibres, and proceeds forwards under the dura mater to the foramen rotundum through which it passes into the spheno-maxillary fossa. The nerve is now carried across the upper part of this fossa and enters the infra-orbital canal, where it receives the name of *infra-orbital.* Finally it emerges upon the face through the infra-orbital foramen, and breaks up, under cover of the levator labii superioris, into numerous branches, which form a dense plexus with twigs from the facial nerve. Its terminal filaments are distributed to the lower eyelid, the nose, and the upper lip. From its origin within the cranium to its termination on the face, the superior maxillary nerve pursues a nearly straight course, and in each stage it gives off one or more branches. These are:—

1. Within the cranium,	Recurrent (already described, p. 356).	
2. In the spheno-maxillary fossa, . .	Orbital or temporo-malar (already described, p. 379).	
	Spheno-palatine.	
	Posterior superior dental.	
3. In the infra-orbital canal, . . .	Middle superior dental.	
	Anterior superior dental.	
4. In the face, . .	Palpebral,	already described, p. 287.
	Nasal,	
	Labial,	

The *temporo-malar nerve*, which has already been dissected in the orbit, can now be traced back to its origin from the superior maxillary nerve in the spheno-maxillary fossa. The *spheno-palatine branches* are two stout twigs which arise from the under aspect of the superior maxillary nerve, and proceed vertically downwards in the spheno-maxillary fossa to Meckel's ganglion, of which they constitute the *sensory roots.*

Superior Dental Nerves (nervi alveolares superiores).—These are usually three in number, and are distinguished as posterior, middle, and anterior. The middle superior dental nerve is sometimes absent as a separate trunk, in

which case it arises in common with the anterior superior dental.

The *posterior superior dental nerve* takes origin in the spheno-maxillary fossa, and almost immediately divides into two branches, which proceed downwards upon the posterior aspect of the body of the superior maxillary bone. They contribute a few fine filaments to the mucous membrane of the cheek and to the gum, and then disappear into the minute posterior dental foramina to supply the three

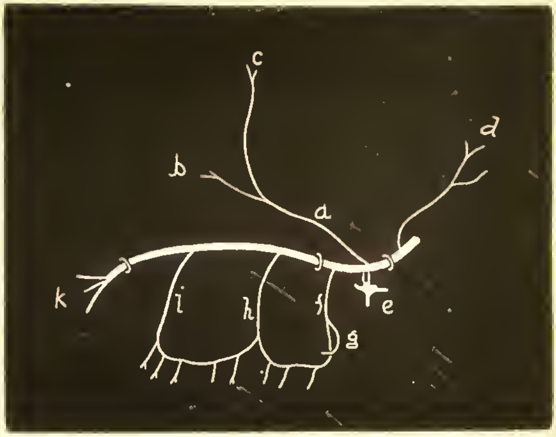

FIG. 258.—Diagram of the superior maxillary nerve.

a. Temporo-malar.
b. Subcutaneus malæ.
c. Temporal branch.
d. Recurrent branch.
e. Meckel's ganglion.
fg. Posterior superior dental nerve.
h. Middle superior dental nerve.
l. Anterior superior dental nerve.
k. Facial branches of infra-orbital.

molar teeth and the lining membrane of the antrum of Highmore.

The *middle superior dental nerve* supplies the two bicuspid teeth. It arises from the infra-orbital nerve, a short distance in front of the spheno-maxillary fossa, and can be easily detected (when present) by gently raising the parent trunk from the floor of the canal. It descends in a minute canal which traverses the outer wall of the antrum of Highmore.

The *anterior superior dental nerve*, much the largest of the three dental branches, springs from the infra-orbital as it approaches the fore part of the canal. It can be brought into view by raising the parent trunk from the floor of the canal, and it will then be seen to enter a special bony tunnel which traverses the upper jaw in front of the antrum of Highmore. The dissector should endeavour to open up this canal with the chisel. After supplying a branch to the mucous membrane of the lower and fore part of the nasal fossa, the anterior superior dental nerve divides into branches for the incisor and the canine teeth.

While traversing the upper jaw, the three superior dental branches communicate with each other, and form two nerve-loops. Numerous twigs proceed from these, and join in a fine plexus. It is from this plexus that the terminal filaments to the teeth and gum take origin.

The Infra-orbital Artery is a branch of the internal maxillary. It arises in the spheno-maxillary fossa, and accompanies the infra-orbital nerve. In the face its terminal twigs anastomose with branches of the facial, transverse facial, and buccal arteries ; in the infra-orbital canal it gives some fine branches to the contents of the orbital cavity, and also the *anterior dental artery* (arteria alveolaris superior anterior), which accompanies the nerve of that name, and supplies the incisor and canine teeth, and the lining membrane of the antrum.

The *infra-orbital vein* joins the pterygoid plexus.

OTIC GANGLION—NASAL FOSSÆ—MECKEL'S GANGLION—INTRAPETROUS PORTION OF THE FACIAL NERVE.

Dissection.—The portion of the lower jaw which still remains, together with the tongue and larynx, must now be removed from the upper part of the skull. From the angle of the mouth on each side carry the knife backwards through the buccinator and mucous membrane of the cheek, the pterygo-maxillary ligament, and the lateral wall of the

pharynx. The internal pterygoid muscle has already been divided, but it will be necessary to cut the internal carotid artery with the vessels and nerves which still connect the pharynx with the skull. The larynx and tongue may be laid aside for future dissection.

The fore part of the skull should next be divided into two lateral parts by sawing it through in the sagittal direction close to one side of the nasal septum. As a general rule the nasal septum is not vertical, but deviates more or less to one or other side of the mesial plane. This deviation is more frequently directed to the right than to the left side. Endeavour to determine the direction which it takes in the skull under observation by passing a probe into the nasal fossæ through the posterior nares. The section through the skull should be made close to the concave side of the septum. Begin in front by introducing a knife into the nostril of that side, and carry it upwards through the cartilaginous part of the nose to the nasal bone. Then place the specimen so that the face rests upon the table, and divide the soft palate from before backwards in the same plane. The section may now be completed by sawing from behind forwards through the hard palate and bony roof of the nasal fossa. The dissector should make every effort to preserve the septum of the nose intact. As a general rule the upper turbinated bone is partially injured. This is not a very serious matter, as the outer aspect of the nasal fossa can be studied upon the opposite side when the septum of the nose has been removed.

If the part has been well preserved, the dissector should be able at this stage to expose the otic ganglion, and perhaps also some of its more important connections. Turn the specimen so that its inner surface looks upwards, and carefully detaching the levator palati from its origin throw it downwards. Then remove the cartilaginous part of the Eustachian tube. In doing this, the dissector must proceed with the greatest caution, because the ganglion lies immediately subjacent. By following the nerve to the internal pterygoid muscle upwards and backwards to its origin the otic ganglion will be discovered.

The Otic Ganglion is an oval, somewhat flattened body, the long axis of which runs in the antero-posterior direction, and measures 4 m.m. It is placed immediately below the foramen ovale, between the deep surface of the inferior maxillary nerve, and the cartilaginous part of the Eustachian tube. The middle meningeal artery lies behind it. Two connecting filaments bind it to the inferior maxillary nerve, and it either covers or surrounds the origin of the nerve to the internal pterygoid muscle.

The otic ganglion is usually described as receiving motor, sensory, and sympathetic roots. The *motor* and *sensory* roots are, in all probability, both supplied by the nerve to the internal pterygoid muscle; the *sympathetic root* comes from the plexus around the middle meningeal artery. In addition to these, the *small superficial petrosal nerve* enters the posterior border of the ganglion, and conveys to it sensory fibres from the glosso-pharyngeal nerve, and probably also motor fibres from the facial nerve (p. 342, Fig. 240).

The following are the *branches* which proceed from the otic ganglion:—

Branches of distribution.	A twig which passes downwards and forwards to the tensor palati. A twig which proceeds upwards and backwards to supply the tensor tympani.
Connecting branches.	One or more fine filaments to one or both of the roots of the auriculo-temporal nerve. A minute communicating filament to the chorda tympani.

Nasal Septum.—The nasal septum divides the cavity of the nose into two narrow chambers—the right and left nasal fossæ. It is not placed accurately in the mesial plane, but almost invariably shows a bulging or deviation to one or other side, so as to reduce the width of one fossa, and increase the capacity of the other. Immediately above the anterior aperture of the nasal fossa the septum shows a slight depression, which corresponds to the *vestibule* of the nose, and forms the inner wall of this subdivision of the chamber. The vestibular part of the partition is clothed by skin, continuous with the external integument; from this a number of stiff hairs, termed *vibrissæ*, project. Over the rest of its extent the septum nasi is covered with mucous membrane, which is divided into two districts, viz., a lower or respiratory area, and an upper or olfactory area, in which the branches of the olfactory nerve spread out. The respiratory mucous membrane is very thick and spongy. It is highly vascular, and contains numerous racemose glands. The minute orifices of the gland ducts can be detected by the naked eye. Over the olfactory district of the septum, the mucous membrane is softer and

more delicate, and not so thick. In the fresh state it presents a yellowish colour, and the glands are smaller and not so plentiful.

In favourable eases a minute orifiee may be deteeted in the mueous membrane on the lower and fore part of the nasal septum immediately behind the vestibular area. It is plaeed above the anterior end of a well-marked elongated projeetion whieh passes obliquely baekwards and upwards, and corresponds to the thiekened lower margin of the septal

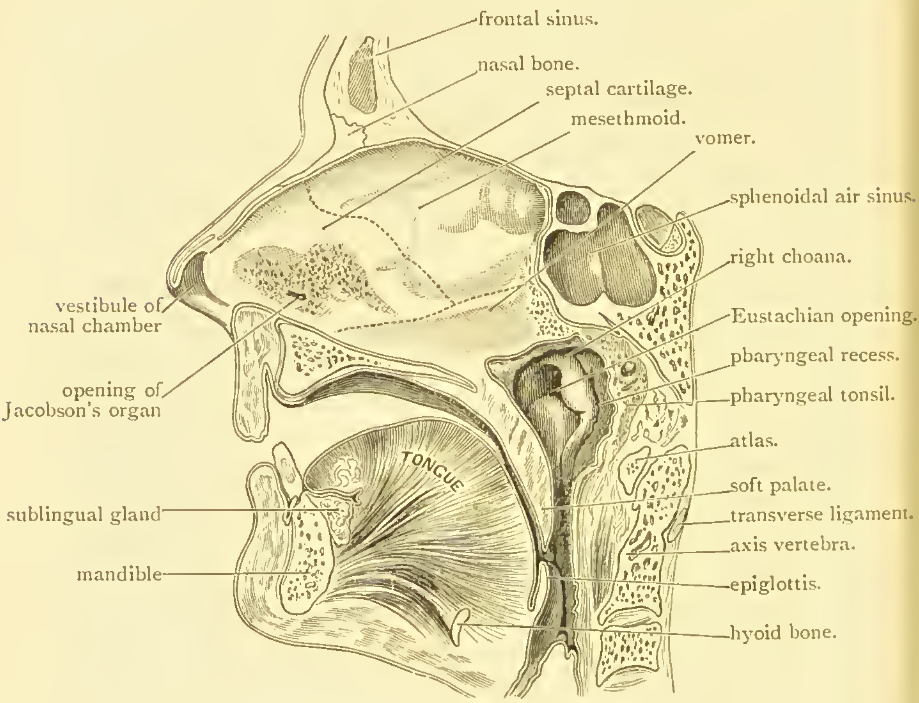

FIG. 259.—Antero-posterior section through the nose, mouth, and pharynx, a little to the left of the mesial plane.

eartilage. This aperture varies in diameter from ½ m.m., to 1½ m.m. (Sehwalbe). It leads into a narrow eanal, whieh passes backwards for a short distanee, and then ends blindly. It is of interest beeause it represents in the human subject the rudiment of the *organ of Jacobson*, a tubular strueture whieh is highly developed in some of the lower animals.

Construction of the Nasal Septum.—Strip the mucous membrane from the exposed surface of the septum nasi.

By this proceeding the intimate connection which exists between the mucous membrane and the subjacent periosteum and perichondrium will become apparent, and the parts forming the septum will be rendered visible. The bulk of the partition is composed of the perpendicular plate of the ethmoid and the vomer posteriorly, and of the septal cartilage in front. Small portions of other bones take a minor part in its construction. Thus, above and behind there are the crest and rostrum of the sphenoid; above and in front is the nasal spine of the frontal bone; whilst below there is the crest of bone formed by the apposition of the palatal processes of the palate and superior maxillary bones of opposite sides.

The *septal cartilage* fills up the wide angular gap which intervenes between the perpendicular plate of the ethmoid and the vomer, and it projects forwards towards the point of the nose. It is a broad irregularly quadrilateral cartilaginous plate. Its *upper and posterior border* is in apposition with the fore border of the mes-ethmoid; its *lower and posterior border*, much thickened, is received into the groove in the fore border of the vomer and the incisor crest of the maxillary bones. The angle between these two borders is prolonged backwards for a varying distance in the form of a tongue-shaped cartilaginous process, which occupies the interval between the two plates of the vomer. The *upper and anterior border* of the septal cartilage is in contact above with the suture between the two nasal bones; below this it is related to the two lateral cartilages of the nose, whilst still lower down it is seen in the interval between the two cartilages of the nasal aperture. Its connection with the lateral cartilage of each side is a very intimate one, indeed, below the nasal bones the three cartilages may be considered to be directly continuous, but lower down they are separated by a fissure which runs upwards for some distance on each side. The *lower and anterior border* is very short; it is free, and extends backwards to the anterior

nasal spine. The anterior angle of the septal cartilage is blunt and rounded, and does not reach to the point of the nose, which is thus formed by the cartilages of the aperture (p. 303).

The deviation of the septum nasi from the mesial plane will now (in all probability) be seen to be due to a bulging to one side of the vomer and mes-ethmoid along their line of union. It is not developed until after the seventh year of life (Zuckerkandl).

Dissection.—The septal cartilage and thin bony laminæ must now be removed piecemeal. This must be done very carefully, as it is necessary to preserve intact the mucous membrane which clothes the opposite side of the septum. It is in this that the nerves and blood vessels must be examined.

Vessels and Nerves of the Septum Nasi.—The following is a list of the nerves:—

Nerves of Smell, .	Olfactory.
Nerves of Common Sensation, . .	1. Naso-palatine, or nerve of Cotunnius. 2. Septal branch of the nasal nerve proper. 3. Nasal branches from Meckel's ganglion and the Vidian nerve.

The *inner group of olfactory nerves* which are distributed in the mucous membrane of the upper part of the nasal septum are barely distinguishable, except in a fresh part; further, they are so soft that it is hardly possible to isolate them. They enter the nasal fossa through the inner series of apertures in the cribriform plate of the ethmoid, and proceed downwards in grooves on the surface of the perpendicular plate of the same bone. Upon the deep surface of the mucous membrane they form a close meshed plexus of nerves.

The *naso-palatine nerve* (nerve of Cotunnius) is a long slender twig which can easily be detected upon the deep surface of the mucous lining of the septum. It springs from Meckel's ganglion, and enters the nasal fossa through the spheno-palatine foramen. In the first part of its course

it runs horizontally inwards upon the under surface of the body of the sphenoid. Having gained the nasal septum, it changes its direction and proceeds downwards and forwards in a shallow groove on the surface of the vomer under cover of the mucous lining. Finally it enters the foramen of Scarpa, and where the two foramina of Scarpa open into the common anterior palatine canal, the nerves of opposite sides unite in a plexus from which branches are given to the mucous membrane covering the fore part of the hard palate. The naso-palatine nerve is accompanied by the corresponding artery, and as it lies on the surface of the vomer, it supplies some small twigs to the mucous membrane of the septum nasi.

A few *nasal branches* from Meckel's ganglion, and also from the Vidian nerve, reach the mucous membrane over the upper and back part of the septum. They are very minute, and it is very questionable if the dissector will be able to discover any trace of them.

The *septal branch of the nasal nerve proper* will be found descending over the fore part of the nasal septum. It runs between the mucous membrane and the septal cartilage, and its terminal twigs may be traced as far as the vestibule.

The *arteries* which convey blood to the septum nasi are: (1) the naso-palatine, which accompanies the nerve of the same name; (2) a branch of the anterior ethmoidal accompanying the septal branch of the nasal nerve; (3) some minute twigs to the upper part of the septum from the posterior ethmoidal artery; (4) the septal branch of the superior coronary artery, which is distributed upon the columna nasi.

Dissection.—The mucous membrane of the septum may now be divided by the scissors along the roof of the nasal cavity. Before doing this, disengage from its surface the naso-palatine nerve and the septal branch of the nasal nerve proper, in order that they may be afterwards traced to their origins. When the layer of mucous membrane thus detached from the roof of the nose is thrown inwards the nasal fossa is exposed.

The Nasal Fossæ are two chambers placed one on each side of the septum nasi. They are extremely narrow, but the vertical depth and antero-posterior length of each fossa is very considerable. The width increases somewhat from above downwards; thus, in the upper part, the superior

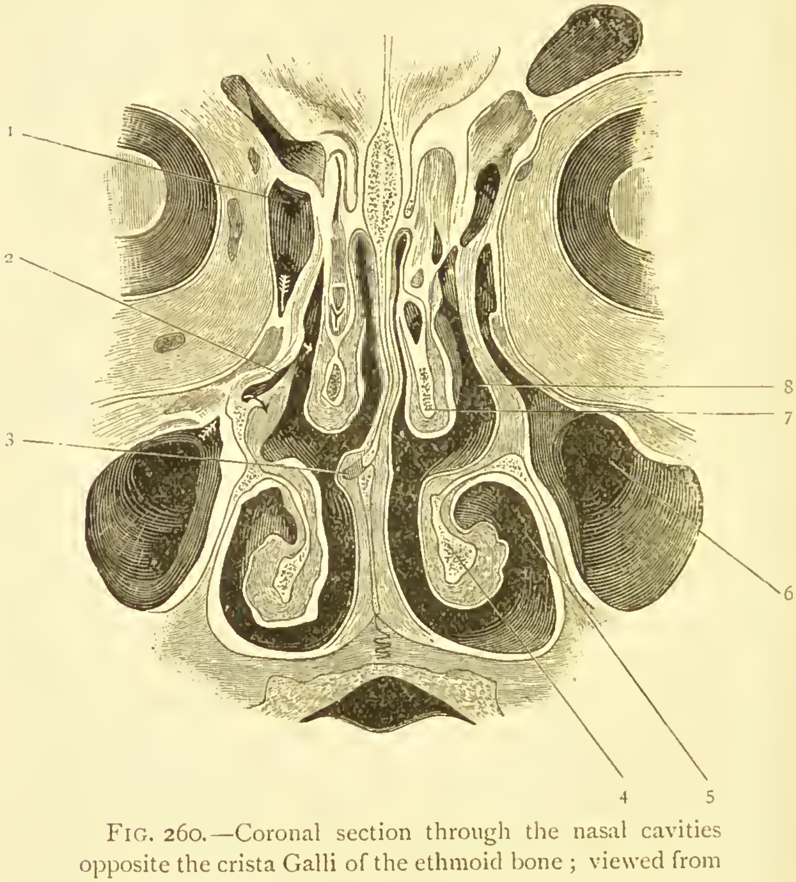

FIG. 260.—Coronal section through the nasal cavities opposite the crista Galli of the ethmoid bone; viewed from behind.

1. Anterior ethmoidal cell.
2. Infundibulum.
3. Posterior angle of septal cartilage between vomer and perpendicular plate of ethmoid.
4. Inferior turbinated bone.
5. Inferior meatus.
6. Antrum of Highmore.
7. Middle turbinated bone.
8. Middle meatus.

The *upper arrow* passes through the opening of the anterior ethmoidal cell into the infundibulum. The *lower arrow* passes from the antrum of Highmore into the infundibulum.

turbinated bone is only separated from the septum by an interval of 2 m.m., whilst lower down we find a space of 4 or 5 m.m. intervening between the inferior turbinated bone and the septum. Each nasal fossa presents an inner wall formed by the septum, an outer wall, a roof, a floor, and an anterior and a posterior aperture.

The *anterior apertures* of the nasal fossæ or nostrils are two oval orifices which open upon the face and look downwards. The *posterior apertures* or *choanæ* open into the upper part of the pharynx and look directly backwards.

The narrow *roof* of the nasal fossa consists of an *intermediate* horizontal portion formed by the cribriform plate of the ethmoid bone, and of an anterior and a posterior sloping part. The *anterior part* inclines downwards and forwards, and is formed by the narrow grooved nasal surface of the spine of the frontal bone, the nasal bone, and the angle between the lateral cartilage and the septal cartilage. The *posterior part* of the roof, which slopes downwards and backwards, is composed of the fore and under surfaces of the body of the sphenoid, as well as the spread-out ala of the vomer and the sphenoidal process of the palate bone, both of which are applied to the under surface of the sphenoidal body.

The *floor* of the nasal fossa is wider than the roof. It is formed by the palatal processes of the superior maxillary and palate bones, and is concave from side to side. Further, it presents a gentle slope from before backwards, so that it is slightly higher in front than behind. On the anterior part of the floor, and close to the septum nasi, the dissector may observe a minute funnel-shaped depression of the mucous membrane into the incisor foramen. This is of interest from a developmental point of view ; it is a vestige of the extensive communication which existed in the embryo between the cavities of the nose and the mouth.

Outer Wall of the Nasal Fossa.—The outer wall of the nasal cavity is rendered uneven and complicated by the pro-

jection of the three turbinated bones. In front, it is formed by the lateral cartilage, the cartilage of the aperture, the nasal bone, and the ascending process of the superior maxillary bone. Behind these, the lachrymal, the ethmoid, and the inferior turbinated bones, with a small portion of the body of the superior maxillary bone, enter into its construction; whilst, still farther back, are the vertical plate of the palate bone and the internal pterygoid plate of the sphenoid. Placed in relation to the outer aspect of this wall are the ethmoidal air-cells, which intervene between the upper part of the nasal cavity and the orbit, whilst, at a lower level, the great air-sinus of the superior maxillary bone, termed the antrum of Highmore, is situated immediately to the outer side of the nasal fossa (Fig. 260).

The part which the different bones take in the formation of the outer wall of the cavity of the nose must in the first place be studied in a sagittal section through the macerated skull, and the dissector should constantly refer to such a preparation during the dissection.

Turning now to the recent specimen, the dissector will observe that the outer wall may very readily be subdivided into three areas or districts. These are—(1) the vestibule, (2) the atrium meatus medii, (3) the region of the turbinated bones and intervening meatuses.

Vestibulum Nasi.—The *vestibular part* (Fig. 261, 6′, 6) of the outer wall is a depression of a somewhat oval form placed immediately above the aperture of the nostril. It is partially divided into an upper and lower portion by a short ridge which projects forwards from its posterior boundary, and it is clothed throughout by integument continuous with the skin. From this a number of stout, stiff hairs, termed *vibrissæ*, project (Fig. 261, 5). The vibrissæ which spring from the anterior part of the region incline backwards, whilst those which are implanted into the posterior part are directed forwards; in this manner a sieve-like arrangement is provided at the anterior aperture of the nose. The vestibular part of the outer wall is placed opposite the corresponding area on

the septum nasi, and the two together constitute an ampullated entrance to the nasal fossa. The capacity and shape of this section of the cavity is influenced to a certain extent by the contraction of the nasal muscles.

The Atrium Meatus Medii (Fig. 261, 8) is placed above, and slightly behind the vestibular district, and it receives its name from the fact that it leads directly backwards into the

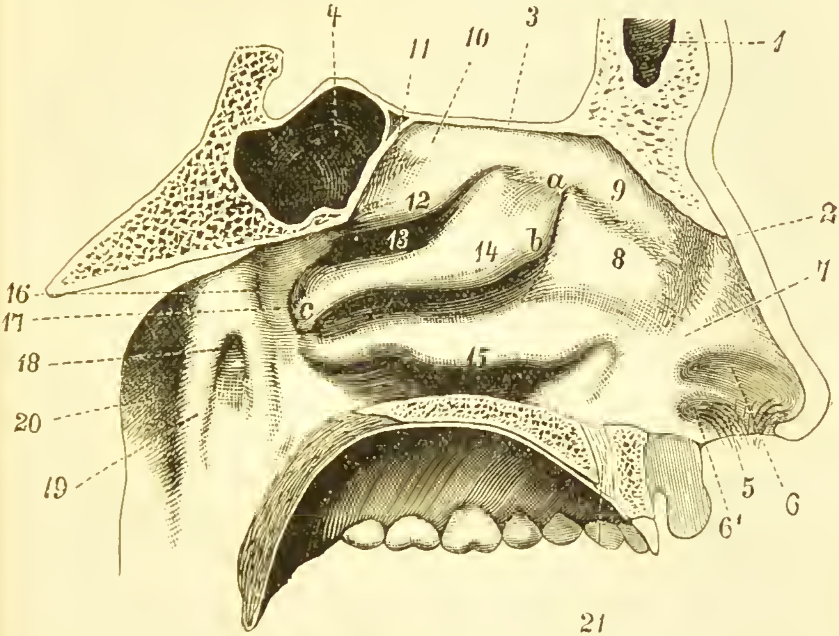

FIG. 261.—Outer wall of the left nasal fossa. (From SCHWALBE.)

1. Frontal air-sinus.
2. Free border of the nasal bone.
3. Cribriform plate of ethmoid.
4. Sphenoidal air-sinus.
5. Vibrissæ.
6', 6. Two parts of the vestibular area.
7. Elevation intervening between the vestibular district and the atrium.
8. Atrium meatus medii.
9. Aggar nasi, or rudiment of an anterior turbinal.
10. Upper part of the superior turbinated bone (concha suprema).
11. Recessus spheno-ethmoidalis.
12. Superior turbinated bone.
13. Superior meatus.
14. Middle turbinated bone.
15. Inferior turbinated bone.
16. Plica naso-pharyngea.
17. District intermediate between nose and pharynx, and termed the region of the ductus naso-pharyngeus.
18. Orifice of Eustachian tube.
19. Prominent inner lip of this orifice.
20. Wall of pharynx.
21. Anterior palatine canal.

a b c. Free border of the middle turbinated bone.

middle meatus of the nose. It is slightly hollowed out and concave, and on its upper part, near the nasal bone, a feeble elevation may sometimes be noticed, which begins close to the fore part of the attached margin of the middle turbinated bone, and proceeds obliquely downwards and forwards (Fig. 261, 9). This has been termed by Schwalbe, the "rudiment of the anterior turbinal," and he considers that it is the representative of the naso-turbinal which is present in some mammals.

Turbinated Bones.—Behind the vestibule and the atrium are the turbinated bones with the intervening meatuses. The *superior turbinated bone* (Fig. 261, 12), which projects from the lateral mass of the ethmoid bone, is very short, and is placed on the upper and back part of the outer wall of the fossa. Its free border begins a short distance below the centre of the cribriform plate, and proceeds obliquely downwards and backwards to a point immediately below the body of the sphenoid, where it ends. The *middle turbinated bone* (Fig. 261, 13) is also a part of the ethmoid. Its free border begins a short distance below the fore part of the cribriform plate, and at first takes a vertical course downwards (*a* to *b*); then, bending suddenly, it proceeds backwards, and ends midway between the body of the sphenoid and the posterior border of the hard palate (*c*). The *inferior turbinated bone* (Fig. 261, 15) is an independent bone, and stretches backwards upon the outer wall of the nasal fossa, midway between the middle turbinated bone and the floor of the nose. Its lower free margin is somewhat convex from before backwards.

Meatuses of the Nose.—The *superior meatus* (Fig. 261, 13) is a short narrow fissure between the superior and middle turbinated bones. The posterior ethmoidal cells open into its upper and fore part by one, or, in some cases, by several apertures.

To bring these orifices into view, the superior spongy bone should be turned aside by introducing the blade of a pair of forceps under its entire

length, and forcing it upwards. Care should be taken not to injure the mucous membrane more than is absolutely necessary.

The *middle meatus* is a much more roomy passage which lies between the middle and inferior turbinated bones, and is continued directly forwards into the atrium.

The middle spongy bone should be forcibly tilted upwards and backwards.

Upon the lateral wall of the middle meatus a deep curved groove or gutter, which runs from above downwards and backwards, will be observed. In this groove, which is termed the *infundibulum* (Fig. 262), are the openings of the frontal sinus, the anterior ethmoidal cells, and the antrum of Highmore. The aperture of the frontal sinus is a small circular opening placed at the upper and fore extremity of the infundibulum. The anterior ethmoidal cells, as a general rule, open a short distance lower down; in some cases, however, the aperture may be placed above the groove (Fig. 262). The slit-like opening of the antrum of Highmore will be noticed in the hinder part of the infundibulum.

The dissector should now proceed to open up the antrum of Highmore by removing its outer wall. This may be done by sawing upwards through the root of the zygomatic process of the superior maxillary bone.

The orifice by means of which this great air sinus communicates with the middle meatus will be noticed to be placed on the inner wall of the cavity much nearer the roof than the floor—a position highly unfavourable for the escape of fluids which may collect within it. Sometimes, however, a second orifice, circular in outline, will be found. This is situated lower down, and opens into the middle meatus immediately above the middle point of the attached margin of the inferior turbinated bone.

The *inferior meatus* is the horizontal passage which extends backwards between the inferior turbinated bone and the floor of the nasal fossa. It is placed behind the vestibule, and the free border of the projection, which corre-

sponds to the inferior turbinated bone, turns downwards in front so as to limit it anteriorly (Fig. 261). This condition, together with the backward slope of the floor, renders the inferior meatus more accessible to the current of expired air than to the current of inspired air (Schwalbe). In the fore part of this meatus will be found the opening of the

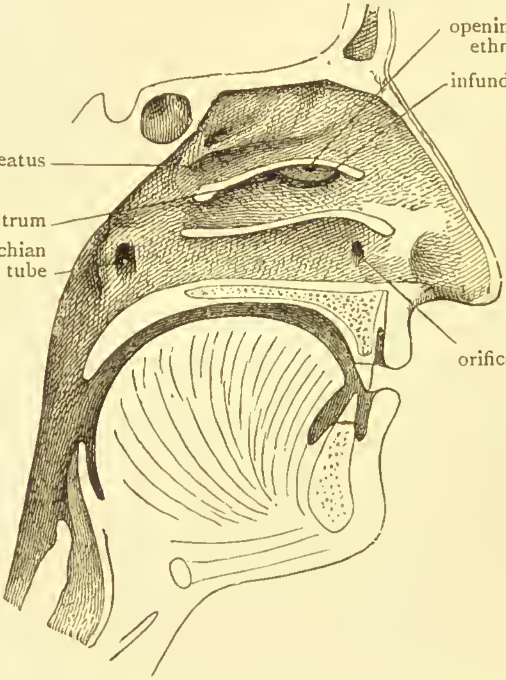

FIG. 262.—Outer wall of nasal fossa. (From GEGENBAUR.) The middle and inferior turbinated bones have been taken away.

nasal duct—the canal which conveys the tears to the nasal fossa (Fig. 262).

To bring the aperture of the nasal duct into view, remove a small portion of the anterior part of the inferior turbinated bone with the scissors.

The orifice of the nasal duct varies in form, according to the manner in which the mucous membrane is arranged around it. Sometimes it is wide, patent, and circular; at

other times the mucous membrane is prolonged inwards beyond the bony opening, so as to reduce the size of the aperture and even give it a slit-like character. In some cases indeed the orifice may be so minute that it is a difficult matter to find it. Its continuity with the lachrymal sac should in all cases be established by passing a probe from above downwards through the nasal duct.

A *fourth* meatus is generally present on the outer wall of the nose. It is not at all uncommon to find the superior turbinated bone partially subdivided into an upper and lower part by a short fissure, which proceeds forwards from the anterior aspect of the body of the sphenoid. This additional meatus is termed the *recessus spheno-ethmoidalis* (Meyer), and into its back part opens the aperture of the sphenoidal air sinus (Fig. 261, 11). This orifice may be circular or slit-like, according to the manner in which the mucous membrane is disposed around it.[1] The upper portion of the superior turbinated bone which is placed above this additional meatus is called the *concha suprema* (Fig. 261, 10).

Mucous Membrane of the outer Wall of the Nose.—The vestibule, as we have noted, is lined by integument. The remainder of the outer wall, as well as the roof and floor of the nasal fossa, is lined by mucous membrane, which is continuous through the nasal duct with the ocular conjunctiva, through the various apertures with the delicate lining membrane of the air-cells which open into the nose, and through the posterior nares with the pharyngeal mucous membrane. On the outer wall, as on the septum, the mucous membrane is mapped out into an upper olfactory and a lower respiratory portion. This subdivision cannot be appreciated by the naked eye, as the one district passes without any sharp line of demarcation into the other. The

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[1] When the recessus spheno-ethmoidalis is absent, the sphenoidal air sinus opens into the interval between the roof of the nasal fossa and the superior turbinated bone.

olfactory region comprises the upper and middle turbinated bones with the superior meatus; the *respiratory region* includes the inferior turbinated bone, the middle meatus, the lower meatus, and the greater part of the atrium. In the lower part of the outer wall the mucous membrane is thick and spongy. This is particularly noticeable over the lower borders and posterior extremities of the middle and inferior turbinated bones, where the membrane presents an irregular surface and forms soft bulging cushions. This condition is largely due to the presence of a rich venous plexus, the vessels of which run for the most part in an antero-posterior direction. In the case of the lower spongy bone, the veins are so numerous that the mucous membrane assumes the character of cavernous tissue, and is sometimes spoken of as the "erectile body." When turgid with blood, it swells out so as to obliterate the interval between the turbinal bone and the septum. The mucous membrane of the floor, meatuses, and the atrium, is smoother and not so thick as that over the turbinated bones. Everywhere numerous racemose glands are embedded in its midst, and the minute punctiform orifices of the ducts are visible to the naked eye. In the olfactory region the lining membrane of the nose (called the *olfactory* or *Schneiderian membrane*) in the fresh state is of a yellowish colour, and is softer and more delicate than in the respiratory part.

The great vascularity of the mucous membrane of the nose is doubtless for the purpose of moistening and raising the temperature of the inspired air.

Nerves and Vessels on the Outer Wall of the Nasal Fossa:—

Nerves of Smell, .	Olfactory nerves.
Nerves of Common Sensation, . .	1. External branch of nasal proper. 2. Nasal branch of anterior superior dental. 3. Superior nasal branches from Meckel's ganglion and the Vidian nerve. 4. Two inferior nasal branches from the anterior palatine nerve.

The *olfactory nerves* are from twelve to twenty in number. They are fine filaments which spring from the under surface and the extremity of the olfactory bulb, and passing through the apertures in the cribriform plate of the ethmoid into the nose, they separate into an outer and an inner group. To each nerve an investment from the cerebral membranes is given. The *inner* or *septal nerves* have been already described (p. 426). The *outer nerves* descend between the mucous membrane and the periosteum on the outer wall of the nose. At first lodged in shallow grooves or minute bony canals, they soon divide into bunches of branches which spread out over the upper and middle turbinated bones. The dissection of these nerves is exceedingly difficult even in the fresh subject, but in a well-preserved part they can generally be partially displayed.

The *superior nasal branches* which come from the spheno-palatine ganglion and from the Vidian nerve are very minute filaments, but the dissector should not be deterred on this account from endeavouring to trace them to their distribution upon the outer wall. They enter the nose through the spheno-palatine foramen, which is situated at the back part of the superior meatus.

The best plan to adopt for their display is to trace the naso-palatine nerve, which has already been exposed on the nasal septum, outwards across the roof of the nose. This will lead to the foramen, and by carefully dissecting the mucous membrane in its neighbourhood, the superior nasal nerves may be detected entering the nasal fossa.

They are distributed to the mucous membrane over the upper and middle turbinated bones; and some filaments are prolonged to the septum.

The inferior nasal nerves are two in number, and they both arise from the great or anterior palatine nerve.

Carefully raise the mucous membrane from the posterior part of the outer wall of the nasal fossa. Make a vertical incision, through the membrane over the internal pterygoid process, and turn it cautiously over from behind forwards.

The *upper* of the two inferior nasal nerves will be found emerging through a small aperture in the vertical plate of the palate bone, at a point between the posterior extremities of the middle and inferior turbinated bones. It divides into an ascending and descending branch. The former runs forwards on the middle spongy bone; the latter extends forwards upon the inferior spongy bone. The *lower* of the two inferior nasal nerves appears through a foramen in the vertical plate of the palate bone immediately behind the posterior end of the inferior turbinated bone upon the outer surface of which it proceeds in a forward direction.

The *nasal nerve proper* should be exposed as it descends in the groove upon the deep surface of the nasal bone (p. 368). It gives, as we have noted, a branch inwards to the septum; an external twig may also be traced to the mucous membrane over the fore part of the outer wall and to the fore parts of the middle and inferior turbinated bones.

The main *artery* of supply to the nasal mucous membrane is the *spheno-palatine*, a branch of the internal maxillary. It gains entrance to the nasal fossa through the spheno-palatine foramen in company with the superior nasal and naso-palatine nerves. One branch of this vessel—the *naso-palatine*—accompanies the latter nerve, whilst others are distributed upon the outer wall of the cavity. Several twigs are also given by the *descending palatine branch* of the internal maxillary and the *two ethmoidal arteries*, but these are small and will only be seen in cases where the injection of the subject has been unusually successful.

SPHENO-PALATINE GANGLION OR THE GANGLION OF MECKEL.

Dissection.—Meckel's ganglion is placed on the outer side of the spheno-palatine foramen, and can best be exposed at this stage by dissecting from the inside. The mucous membrane has already been removed from the posterior part of the outer wall of the nasal fossa, and the inferior nasal branches of the great palatine nerve have been found

piercing the vertical plate of the palate bone. The dissector cannot fail to notice the course taken by the trunk from which these filaments arise. The lamina of bone which forms the inner wall of the posterior palatine canal is so thin that the nerve can be distinctly seen through it. By carefully opening up this canal with a chisel, and following the great palatine nerve upwards, the dissector will be led to the ganglion in the spheno-maxillary fossa. The naso-palatine nerve should at the same time be traced to its origin. The ganglion is so hemmed in by the bony walls of the fossa that it is very difficult to display it thoroughly, but by removing the orbital process of the palate bone, and a portion of the body of the sphenoid with the bone-forceps, it may be more or less satisfactorily exposed. In the same restricted space will be found the terminal portion of the internal maxillary artery, from which numerous branches are given off.

The Spheno-palatine Ganglion is a small triangular flattened body, which is lodged in the spheno-maxillary fossa. It is embedded in soft fat, and surrounded by the terminal branches of the internal maxillary artery. The two stout spheno-palatine branches which descend from the superior maxillary nerve join it from above, but only a certain proportion of their fibres are involved in the ganglion; the remainder are continued directly into the nasal and palatine nerves which proceed from the ganglion. The spheno-palatine nerves may be regarded as constituting the *sensory roots* of the ganglion.

From the spheno-palatine ganglion branches are given off, which radiate in four directions—viz., inwards to the nose, downwards to the palate, backwards to establish connections with the facial nerve and carotid plexus, as well as to supply the mucous membrane of the pharynx, and upwards to the orbit.

Internal branches, .	Superior nasal. Naso-palatine.
Descending branches,	Great or anterior palatine. Posterior palatine. External palatine.
Posterior branches, .	Vidian. Pharyngeal.
Ascending branches, .	Orbital.

From the internal maxillary artery twigs are given off which accompany these nerves.

The *superior nasal* and the *naso-palatine nerves* have been already described (pp. 426 and 437). They arise from the inner aspect of the ganglion, but in some cases the naso-palatine may be seen to take origin from the commencement of the common palatine trunk, or even from one of the spheno-palatine branches of the superior maxillary nerve (Henle).

The *palatine nerves* are three in number, and are distinguished as *great* or *anterior*, *small* or *posterior*, and *external*. As a rule these spring by a common trunk from the lower aspect of the ganglion. This descends in the posterior palatine canal, which has already been opened up, but to expose the nerves a dense fibrous investment must be removed. The nerve trunk will then be observed to break up into its three constituents.

Dissection.—Trace, in the first instance, the two smaller nerves—viz., the posterior and the external palatine branches. These leave the main canal, and enter smaller tunnels, which conduct them through the tuberosity of the palate bone. Before opening these up, it is well to secure the nerves as they emerge from the lower openings of the canals. This can very readily be done by dissecting behind the hamular process, and gently separating the soft parts from the under aspect of the tuberosity of the palate bone. As the dissection is being made from the inside, the *small*, or *posterior palatine nerve*, will be first encountered, and it will be seen to pass backwards into the soft palate, under cover of the tendinous expansion of the tensor palati.[1] This must be divided, in order that the posterior palatine nerve may be followed to its distribution. The *external palatine nerve* will be found issuing from its canal a short distance to the outer side of the preceding nerve. It is distributed to the soft palate in the neighbourhood of the tonsil. It is smaller than the posterior palatine nerve, and is sometimes absent. The *great* or *anterior palatine nerve* should now be followed onwards to the hard palate. To do this the lower part of the posterior palatine canal must be opened up by removing a small portion of the posterior and outer part of the horizontal plate of the palate bone.

[1] The present is a good opportunity to observe the corrugated or wrinkled appearance of the tendon of the tensor palati, as it passes under the hamular process.

The *great or anterior palatine nerve* as it emerges from the posterior palatine foramen turns forwards, and divides into branches, which lie in grooves on the under aspect of the hard palate. It supplies the gum, the mucous membrane, and glands of the vault of the mouth, and in the neighbourhood of the anterior palatine foramen it effects a communication with the naso-palatine nerve. During its passage through the posterior palatine canal this nerve has already been observed to supply *two inferior nasal branches* (p. 437).

In tracing the great palatine nerve forwards in the palate, the dissector should note the numerous glands which are placed under the mucous membrane of the vault of the mouth, and the manner in which these indent the bone.[1]

Dissection.—Very considerable difficulty will be experienced in exposing the *pharyngeal* and *Vidian nerves.* They proceed backwards from the posterior part of the ganglion in canals which are very inaccessible.

To open up the pterygo-palatine canal the sphenoidal process of the palate bone must be cautiously removed by the bone-forceps, and then the dissector should proceed to open up the Vidian canal, which traverses the root of the pterygoid process. As the bone is very hard and brittle at this point, the dissection must be effected very carefully.

The *pharyngeal nerve* occupies the pterygo-palatine canal, and is distributed to the mucous membrane of the upper part of the pharynx.

The *Vidian nerve* has previously been seen to be formed by a junction between the *great superficial petrosal branch* of the facial and the *great deep petrosal branch* of the carotid plexus (p. 359). It traverses the Vidian canal, and joins the posterior aspect of the ganglion, of which it may be considered to represent both the *motor* and *sympathetic root.* In the canal it is invested by a strong fibrous envelope, and

[1] An equally good method of tracing the posterior palatine nerve forwards is to remove the palatal processes of the palate and superior maxillary bones with the bone-pliers, and then to display the nerve and artery on the upper surface of the mucous membrane and glands.

when this is removed it may sometimes be noticed to break up into a fine plexus which surrounds the accompanying artery. It has already been observed to give some fine filaments to the mucous membrane of the nose.

The *orbital branches* of the ganglion are exceedingly minute, and ascend through the spheno-maxillary fissure to supply the periosteum of the orbit.

Termination of Internal Maxillary Artery.—The internal maxillary artery breaks up into its terminal branches in the spheno-maxillary fossa. These have already been traced. They are—

1. The posterior dental (arteria alveolaris superior posterior) (p. 311).
2. The infra-orbital (p. 421).
3. The descending palatine.
4. The Vidian.
5. The pterygo-palatine.
6. The spheno-palatine.

The *descending palatine* (arteria palatina descendens) accompanies the *great* or *anterior palatine nerve.* During its passage through the posterior palatine canal, it gives off twigs which accompany the posterior and external palatine nerves and the two inferior nasal branches of the great palatine nerve. On the hard palate it dispenses branches to the gum, mucous membrane, and glands, and sends a small branch upwards through the incisor foramen to anastomose with the naso-palatine artery.

The *Vidian artery* (arteria Vidiana) runs backwards in the Vidian canal to supply the mucous membrane of the upper part of the pharynx and of the Eustachian tube.

The *pterygo-palatine artery* traverses the canal of the same name, and has a corresponding distribution.

The *spheno-palatine* (arteria sphenopalatina) enters the nasal fossa through the spheno-palatine foramen, and has already been followed to its distribution (p. 438).

Dissection.—The facial and auditory nerves, together with the pars intermedia, have already been traced into the internal auditory meatus

(p. 127). The dissector should now open up this meatus and follow the facial nerve in its course through the petrous portion of the temporal bone. The canal which it occupies is termed the *aqueduct of Fallopius*. This begins at the bottom of the internal auditory meatus, and opens on the exterior of the skull at the stylo-mastoid foramen. Between these points it pursues a complicated course, and this, combined with the density of the bone, renders the dissection very difficult. Perhaps the easiest method of opening up the aqueduct is, in the first instance, to decalcify the bone in a weak solution of acid, but, at the same time, it should be clearly understood that, with a little care, there is nothing to hinder the dissector carrying out the dissection on the hard bone by means of the saw and the chisel.

Separate the temporal bone from the other cranial bones which still adhere to it, and, having fixed it in its natural position (in a vice if possible), remove the squamous portion by a horizontal saw-cut at the level of the superior border of the petrous bone. A second horizontal saw-cut should then be made through the pars petrosa immediately above the roof of the internal auditory meatus. If this is successfully carried out, the vestibule, the upper part of the tympanum, and the mastoidal cells are opened. Upon the upper part of the inner wall of the tympanum above the stapes and the foramen ovale, a prominent ridge will be noticed running from before backwards. This is the aqueduct of Fallopius. Extend the opening into the tympanum by removing the remainder of its roof, and then, with the chisel, open up the aqueduct as seen in this part of its course. The facial nerve is now exposed in what may be said to be its intermediate or tympanic part. To display its first stage within the bone, open up the internal auditory meatus by removing what remains of its roof, and follow the facial nerve forwards and outwards by means of the chisel. This will lead to the geniculate ganglion—the swelling which marks the point at which the nerve bends backwards to enter the tympanic part of the aqueduct. Be careful at this point to secure the branches which proceed from the gangliform enlargement. The terminal part of the aqueduct of Fallopius is vertical, and its course can be indicated by pushing a fine pin upwards through the stylo-mastoid foramen. To open it, the mastoid process must be removed by a coronal (vertical-transverse) saw-cut on a plane immediately behind the stylo-mastoid foramen. When this has penetrated the bone as far as that foramen, a second saw-cut should be made in the sagittal (antero-posterior and vertical) direction, to meet the extremity of the first. The piece of bone thus marked out may now be detached, and a little work with the chisel will display the facial nerve in this part of the canal. Three branches are given off from it here—viz., the nerve to the stapedius, the chorda tympani, and the communicating branch or

branches to the auricular nerve from the vagus. The last of these is probably destroyed by the dissection, but the other two can be brought into view by gently raising the nerve from the anterior wall of the canal. By using the chisel in front, and to the inner side of the geniculate ganglion, the cochlea will be exposed.

Intrapetrous Portion of the Facial Nerve.—As the facial nerve traverses the petrous bone, it may be divided into four stages, which differ from each other in the relations they present and in the direction which they take. They are :—

1. A part within the internal auditory meatus.
2. A very short part which extends from the bottom of the internal auditory foramen to the geniculate ganglion.
3. A part which occupies that portion of the aqueduct of Fallopius which runs along the inner wall of the tympanum.
4. A part which extends vertically downwards to the stylo-mastoid foramen.

First stage.—In the internal auditory meatus, the facial nerve runs almost directly outwards in company with the auditory nerve and the pars intermedia. In this stage of its course it lies in relation to the upper and fore part of the auditory nerve, and is joined by the pars intermedia. At the bottom of the auditory meatus it enters the aqueduct of Fallopius.

Second stage.—The second part of the facial nerve is very short. It runs outwards with a slight inclination forwards between the vestibule and cochlea, and very soon ends in the swelling termed the *geniculate ganglion.*

Third stage.—At the geniculate ganglion, the facial nerve bends suddenly and then proceeds backwards and slightly downwards in that portion of the aqueduct which runs along the upper part of the inner wall of the tympanum, immediately above the foramen ovale.

The first three portions of the facial nerve are nearly horizontal, and pursue a somewhat V-shaped course. The apex of the V is directed forwards, and corresponds to the geniculate ganglion.

The *fourth stage* is vertical, and arches downwards behind the pyramid to gain the stylo-mastoid foramen.

The *branches* which spring from the facial nerve during its passage through the temporal bone are :—

1. The great superficial petrosal nerve, } from geniculate ganglion.
2. Communicating twig to tympanic branch of the glosso-pharyngeal, } from geniculate ganglion.
3. External superficial petrosal nerve, } from geniculate ganglion.
4. Nerve to stapedius.
5. Chorda tympani.
6. Communicating twigs to the auricular branch of vagus.

The *great superficial petrosal nerve* has already been examined (p. 359). Its origin from the geniculate ganglion of the facial can now be established by breaking through the roof of the hiatus Fallopii with the chisel.

The *communicating branch* to the tympanic nerve arises from the geniculate ganglion, and its union with the tympanic forms the small superficial petrosal nerve (p. 342, Fig. 240).

The *external superficial petrosal nerve* is not always present. It joins the sympathetic plexus which accompanies the middle meningeal artery (p. 359).

The *nerve to the stapedius muscle* arises from the facial as it arches downwards behind the pyramid. It enters the base of the pyramid and thus reaches the stapedius muscle.

The *communicating twigs to the auricular branch* of the vagus arise a short distance above the stylo-mastoid foramen (p. 344).

The Chorda Tympani, which is the pars intermedia set free from the facial nerve, is the largest branch which is given off by the facial during its passage through the aqueduct of Fallopius. It takes origin a short distance above the stylo-mastoid foramen, and arching upwards and forwards in a narrow canal in the petrous portion of the temporal bone (iter chordæ posterius) it appears in the tympanum below the base of the pyramid, and close to the posterior margin of membrana tympani. The bony tunnel which it occupies

can easily be opened up in a decalcified bone, but is somewhat difficult to expose in the hard bone. The chorda tympani now runs forwards upon the upper part of the membrana tympani under cover of the mucous layer. It crosses the handle of the malleus near its root. To display it in this part of its course, the incus bone should be removed. Finally, reaching the anterior end of the tympanic cavity it crosses the processus gracilis of the malleus, and near the inner end of the Glaserian fissure, it enters a canal (canal of Huguier) which conducts it to the exterior of the skull. With a little care the canal of Huguier can be opened up by the chisel and bone-pliers. From this point to its junction with the lingual nerve the chorda tympani has already been traced (p. 320).

The Auditory Nerve.—In the internal auditory meatus the auditory nerve lies at a lower level than the facial, and at the bottom of the passage it splits into two parts. Of these, one is directed forwards to the cochlea, and the other proceeds outwards to the vestibule.

THE LARYNX.

The lateral portions of the lower jaw which are still attached by mucous membrane to the sides of the tongue should be removed, and the dissection of the larynx commenced.

General Construction and Position.—The larynx constitutes the upper expanded portion of the air-passage, specially modified for the production of the voice. Its walls are composed of cartilages, muscles, ligaments, and an internal lining of mucous membrane. Before proceeding with the dissection the student should study the form and connections of the nine laryngeal cartilages in a permanent specimen (*v.* p. 463).

The larynx is placed in the upper and fore part of the neck, where it forms a marked projection. It lies below

the hyoid bone and tongue, whilst inferiorly it is directly continuous with the trachea. In *front* it is covered by the integument and deep cervical fascia, and on either side of the mesial plane by two thin strata of muscles, viz., the sterno-hyoid, the omo-hyoid, the sterno-thyroid and the thyro-hyoid. As a general rule a narrow process of the thyroid body, termed the *central lobe*, is also continued upwards on its anterior surface. On *each side* the lateral lobe of the thyroid body is prolonged upwards upon it, and it is related to the great vessels of the neck. *Posteriorly* it is in relation to the pharynx; by this it is separated from the prevertebral muscles. If we consider the tip of the epiglottis to represent its upper limit, the larynx in the adult may be regarded as being placed in front of the bodies of the third, fourth, fifth and sixth cervical vertebræ; but its position alters somewhat with the movements of the head and also during deglutition.

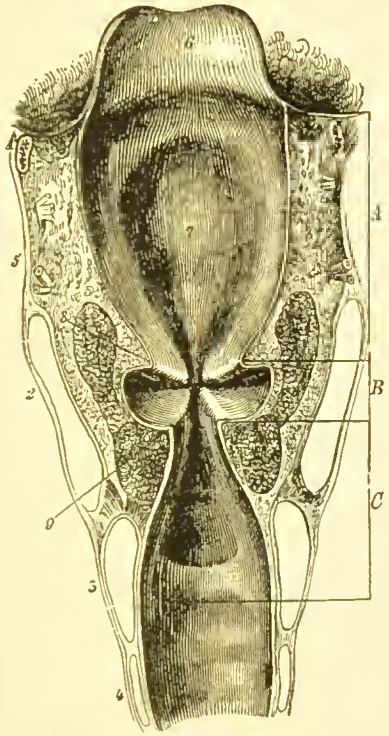


FIG. 263.—Coronal section through the larynx to show the three subdivisions of its cavity, viz., A, B, and C. (From LUSCHKA.)

1. Hyoid bone.
2. Thyroid cartilage.
3. Cricoid cartilage.
4. First tracheal ring.
5. Thyro-hyoid membrane.
6. Epiglottis.
7. Cushion or tubercle of epiglottis.
8. False vocal cord.
9. True vocal cord.

Interior of the Larynx.—The cavity of the larynx is smaller than might be expected from an inspection of its

exterior. On looking into its interior from above it will be seen to be subdivided into three portions by two elevated folds of mucous membrane which extend from before backwards, and project inwards from each side of the cavity. The upper pair of folds are termed the *false vocal cords;* the lower pair receive the name of the *true vocal cords*, because they are the chief agents in the production of the voice. The entire larynx is in a great measure constructed with a view to bring about changes in the relative position and in the degree of tension of the true vocal cords.

The Upper Subdivision of the laryngeal cavity (Fig. 263, A) extends from the superior aperture of the larynx down to the upper or false vocal cords. It is called the *vestibule.* It is bounded in front by the epiglottis and the upper part of the angular depression between the alæ of the thyroid cartilage, behind by the arytenoid cartilages and the mucous membrane which stretches across the mesial plane between them, and on each side by the aryteno-epiglottidean folds. The width of this portion of the laryngeal cavity diminishes from above downwards, and its depth diminishes in a marked degree from before backwards. Above, it communicates with the pharynx by the superior aperture of the larynx, whilst below it is continuous with the middle subdivision of the cavity through the interval between the false vocal cords.

The *superior aperture* of the larynx (ostium pharyngeum laryngis) has already been examined in the dissection of the pharynx (p. 410). The parts which bound it should again be carefully studied.

The *epiglottis* projects upwards behind the root of the tongue. Its lingual or anterior surface is only free in the upper part of its extent, and is attached to the back part of the tongue by a prominent mesial fold of mucous membrane, termed the *middle glosso-epiglottidean fold* or *frænum* of the epiglottis. Two lateral folds are also present which

connect its margins with the tongue; these are called the *lateral glosso-epiglottidean folds*. Between the two layers of mucous membrane which constitute each of these three frænula, there is a small amount of elastic tissue. The depression on each side between the tongue and the epiglottis which is bounded by the median and lateral glosso-epiglottidean folds is termed the *vallecula* (Fig. 264). The posterior free surface of the epiglottis forms, as we have noted, the greater part of the anterior boundary of the vestibule of the larynx. Owing to the tip of the epiglottis being curled forwards, the upper portion of this surface

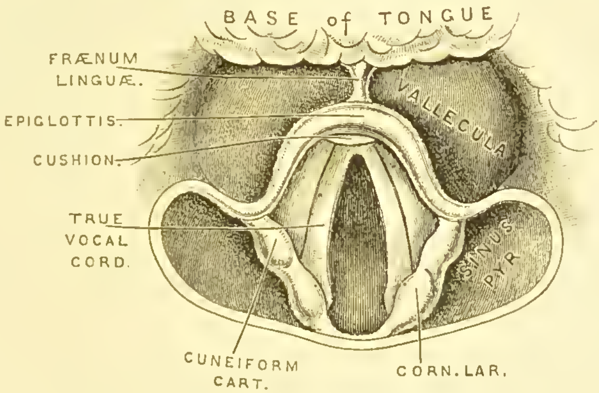


FIG. 264.—The larynx as seen in the living person by means of the laryngoscope.

is convex; this is followed by a slight concavity, and below this it swells out into a marked convexity, called the *cushion* or *tubercle* of the epiglottis. In laryngoscopic examinations the tubercle appears as a conspicuous object.

The *aryteno-epiglottidean folds* of mucous membrane enclose between their two layers some connective tissue, the aryteno-epiglottidean muscles, and posteriorly the cuneiform cartilages, and the cornicula laryngis which surmount the arytenoid cartilages. When the larynx is examined by the laryngoscope these cartilages are visible on either side in the form of two small rounded elevations or tubercles.

Between the outer aspect of the aryteno-epiglottidean fold and posterior part of the ala of the thyroid cartilage, there is a deep depression of mucous membrane on each side, termed the *sinus pyriformis* (p. 411).

The Middle Subdivision of the laryngeal cavity (Fig. 263, B), is the smallest of the three. Above it is bounded by the false vocal cords, below by the true vocal cords, whilst it communicates by the intervals between these folds with the vestibule on the one hand, and the inferior compartment of the larynx on the other.

The *false vocal cords* are two prominent mucous folds which extend from before backwards on the side walls of the laryngeal cavity. They are soft and somewhat flaccid, and present a free border which is slightly arched—the concavity looking downwards. The interval between the false vocal cords is sometimes termed the *false glottis*, and is considerably wider than that between the true vocal cords. It follows from this, that when the cavity of the larynx is examined from above, the four cords are distinctively visible, but when examined from below the true cords alone can be seen.

The *true vocal cords* are placed immediately below the false cords, and are sharp and prominent. The mucous membrane which is stretched over them is so thin that the yellowish colour of the elastic ligaments which support them can readily be discerned. In section each true vocal cord is somewhat prismatic in form, and the free border looks upwards and inwards.

The true vocal cords are the agents by means of which the voice is produced. The false vocal cords are of little importance in this respect; indeed, they can in great part be destroyed, and no appreciable difference in the voice result.

The *rima glottidis* is the elongated fissure by means of which the middle compartment of the larynx communicates with the lower subdivision. It is placed somewhat below

the middle of the laryngeal cavity, of which it constitutes the narrowest part. In front it corresponds to the interval between the true vocal cords; behind it corresponds to the interval between the bases and vocal processes of the arytenoid cartilages (Fig. 265). It is composed, therefore, of two very distinct parts—(1) a narrow anterior portion, between the true vocal cords, involving less than two-thirds of its length, and called the *glottis vocalis;* (2) a broader, shorter portion between the arytenoid cartilages, and termed the *glottis respiratoria.* The form of the rima glottidis undergoes frequent alterations during life, but during ordinary quiet respiration it is lanceolate in outline. The glottis vocalis presents the form of an elongated triangle with the base directed backwards, whilst the glottis respiratoria is somewhat quadrangular. The length of the entire fissure differs considerably in the two sexes, as will be seen from the following figures which are given by Krause:—

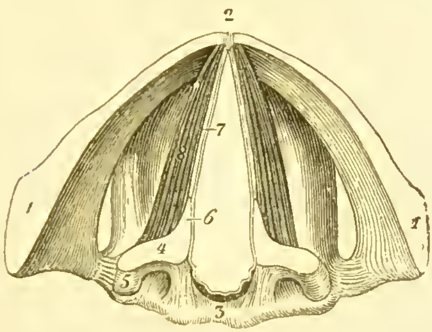


FIG. 265.—Transverse section through the larynx at the level of the true vocal cords. (From LUSCHKA.)

1. Alæ of thyroid cartilage.
2. Median lamina of thyroid cartilage.
3. Upper border of posterior lamina of cricoid cartilage.
4. Arytenoid cartilage.
5. Processus muscularis.
6. Processus vocalis.
7. True vocal cord.
8. Thyro-arytenoideus.

Length of rima glottidis in male,	.	19 to 25 *m.m.*
,, ,, in female,	.	14 to 17 *m.m.*

The side wall of the larynx in the interval between the true and the false vocal cords shows a depression or recess which is termed the *laryngeal sinus.* The dissector should endeavour to gauge the extent of this, by means of a probe bent at the extremity. He will note that the recess passes

upwards, so as to undermine somewhat the false vocal cord, and that its mouth or orifice is narrower than its cavity. Under cover of the fore part of the false vocal cord, an elongated aperture will be detected. This leads into the *laryngeal pouch* or *sac*—a small mucous diverticulum, which ascends between the false vocal cord and the ala of the thyroid cartilage. This sac is of variable extent, but as a rule it ends blindly at the level of the upper border of the thyroid cartilage.

Distend the sinus, and if possible the sac, with cotton wadding. This will greatly facilitate the subsequent dissection.

The Lower Subdivision of the Laryngeal Cavity (Fig. 263, C) leads directly downwards into the trachea. Above it is narrow and laterally compressed, but it gradually widens out until in its lowest part it is circular. It is bounded by the lower part of the thyroid cartilage, the crico-thyroid membrane, and the cricoid cartilage. It is through the anterior wall of this compartment, that the opening is made in the operation of laryngotomy.

The Mucous Membrane of the larynx is continuous above with that lining the pharynx, and below with the mucous lining of the trachea. Over the epiglottis and true vocal cord it is very tightly bound down, and it is plentifully supplied with glands. These, however, are entirely absent over the true vocal cord and also in its immediate vicinity.

Dissection.—Place the larynx upon a block so that its anterior surface looks upwards, and fix it in this position with pins. The branches which the external laryngeal nerve gives to the crico-thyroid muscle should in the first place be followed out, and carefully preserving the superior and inferior laryngeal vessels and the internal and recurrent laryngeal nerves, the dissector should in the next place proceed to remove the thyroid body, and the omo-hyoid, sterno-hyoid, sterno-thyroid, and thyro-hyoid muscles. The fibres of origin of the inferior constrictor muscle should likewise be cleared away from the thyroid and cricoid cartilages. The broad thyro-hyoid membrane, the central portion of the crico-thyroid membrane, and the crico-thyroid muscles are now exposed, and their attachments may be defined.

The Thyro-hyoid Membrane is a broad membranous sheet, which occupies the interval between the hyoid bone and the thyroid cartilage. It is not equally strong throughout, but shows a central thick portion and a cord-like right and left margin, whilst in the intervals between these it is thin and weak. The central thickened part (*ligamentum thyro-hyoideum medium*) is largely composed of elastic fibres. Above, it is attached to the posterior aspect of the upper margin of the body of the hyoid bone, whilst below, it is

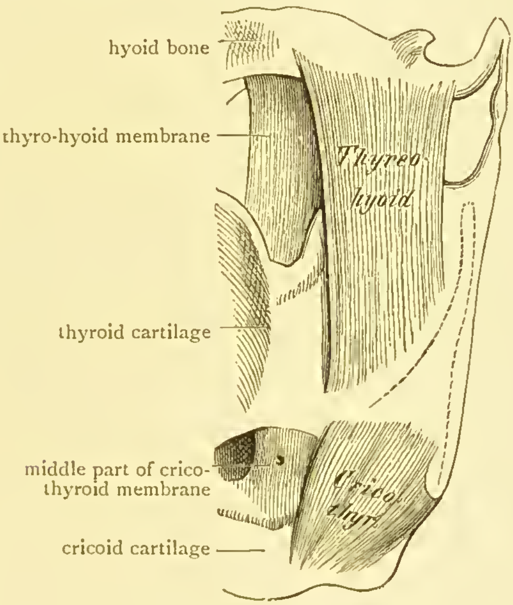


FIG. 266.—(From GEGENBAUR.)

fixed to the sides of the deep median notch, which interrupts the superior border of the thyroid cartilage. The upper part of its anterior surface is therefore placed behind the posterior hollowed out surface of the body of the hyoid bone; a synovial bursa is interposed between them, and in certain movements of the head and larynx the upper border of the thyroid cartilage is allowed to slip upwards behind the hyoid bone. On each side of the strong central part the

thyro-hyoid membrane is thin and loose. It is attached below to the upper margin of the ala of the thyroid cartilage, and above to the posterior aspect of the great cornu of the hyoid bone. It is pierced by the internal laryngeal nerve and superior laryngeal vessels. The posterior border of the membrane on each side is thickened, rounded, and cord-like (*ligamentum thyro-hyoideum laterale*), and is chiefly composed of elastic fibres. It extends from the tip of the great cornu of the hyoid bone to the extremity of superior cornu of the thyroid cartilage. In this ligament there is usually developed a small oval cartilaginous or bony nodule, which is termed the *cartilago triticea.*

The Crico-thyroid Muscle is placed on the side of the cricoid cartilage, and bridges over the lateral portion of the crico-thyroid interval. Taking origin from the lower border and outer surface of the anterior arch of the cricoid cartilage, its fibres spread out in an upward and backward direction, and are inserted into the inner aspect of the lower margin of the thyroid cartilage, and also into the anterior border of its inferior cornu. As a general rule, it is divided into two parts. The *anterior* or *oblique part* is composed of those fibres which are attached to the ala of the thyroid cartilage; the *posterior* or *horizontal part* is formed of those fibres which are inserted into the inferior cornu of the thyroid cartilage. It is closely associated with the inferior constrictor muscle. The crico-thyroid muscle is supplied by the external laryngeal branch of the superior laryngeal nerve.

The Middle portion of the Crico-thyroid Membrane can be studied in the interval between the two crico-thyroid muscles. It is a tense elastic and strong membrane, which is attached below to the median part of the upper border of the anterior arch of the cricoid cartilage, and above to the lower margin of the middle portion of the thyroid cartilage. It is pierced by minute apertures, and is crossed superficially by the crico-thyroid branch of the superior thyroid artery. On each side, under cover of the crico-thyroid muscle, the

lateral part of the crico-thyroid membrane presents very different connections. It is not attached to the lower border of the thyroid cartilage, but stretches upwards into the interior of the larynx, and takes part in the formation of the true vocal cord. At a later stage of the dissection it will be fully exposed.

Dissection.—The position of the larynx must now be reversed. Fix it upon the block in such a manner that its posterior aspect is directed upwards. The œsophagus should then be slit open by a mesial incision through its posterior wall. Next remove with great care the mucous membrane which covers the posterior aspect of the cricoid and arytenoid cartilages. In doing this, bear in mind that the inferior laryngeal artery, and the recurrent laryngeal nerve, pass upwards between the thyroid and cricoid cartilages, and must be preserved.

Upon the posterior aspect of the broad lamina of the cricoid cartilage the dissector will now note the two posterior crico-arytenoid muscles, and the attachment of the anterior band of longitudinal muscular fibres, which belongs to the œsophageal wall. This takes origin from the prominent mesial ridge on the back aspect of the cricoid cartilage. On the posterior surface of the arytenoid cartilages, and bridging across the interval between them, the dissector will observe the arytenoid muscle. Especial care must be taken in cleaning this muscle in order that the connections of the superficial decussating fibres may be fully ascertained.

The outer layer of the right aryteno-epiglottidean fold of mucous membrane should now be cautiously removed. This will expose the aryteno-epiglottidean muscle, the cuneiform cartilage, and the cartilage of Santorini of that side. This is perhaps the most difficult part of the dissection, because the dissector has to establish the continuity of the sparse fibres which compose the pale aryteno-epiglottidean muscle with the decussating fibres of the arytenoid muscle, and he has also to make out a delicate ligament which extends downwards from the tip of the cartilage of Santorini to the cricoid cartilage—viz., the ligamentum jugale.

The Posterior Crico-arytenoid Muscle is somewhat fan-shaped (Fig. 267). It springs by a broad origin from the depression which marks the posterior surface of the cricoid cartilage on each side of the mesial ridge, and its fibres converge to be inserted into the posterior surface and outer angle of the processus muscularis of the arytenoid cartilage.[1]

[1] The projecting outer angle of the base of the arytenoid cartilage.

In pursuing this upward and outward course, the fibres run with different degrees of obliquity. The uppermost fibres are short and nearly horizontal; the intermediate fibres are the longest, and are very oblique; whilst the lowest fibres are almost vertical in their direction.

The Arytenoid Muscle consists of two portions,—a superficial part, termed the arytenoideus obliquus, and a deeper layer, called the arytenoideus transversus.

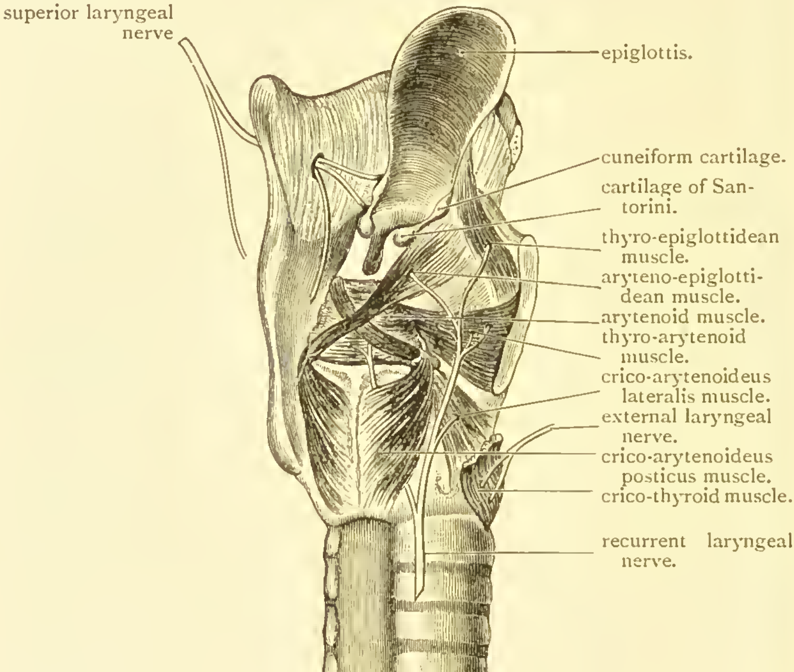


FIG. 267.—Dissection of the larynx viewed from behind and the right.

The *arytenoideus obliquus* is composed of two bundles of muscular fibres, each of which springs from the posterior aspect of the outer angle of the base of the corresponding arytenoid cartilage (Fig. 267). From these points the two fleshy slips proceed upwards and inwards, and cross each other in the mesial plane like the limbs of the letter X.

Reaching the summit of the arytenoid cartilage on each side, some of the fibres are inserted into it, but the greater proportion are prolonged round the base of the cartilage of Santorini into the aryteno-epiglottidean fold. Here they receive the name of the *aryteno-epiglottidean muscle*, and as they approach the epiglottis they are joined by the fibres of the thyro-epiglottidean muscle. The oblique arytenoid muscles may therefore be considered as constituting a weak sphincter muscle for the superior aperture of the larynx. Each bundle starting from the base of one of the arytenoid cartilages is prolonged into the aryteno-epiglottidean fold of the opposite side, and along this to the margin of the epiglottis.

The *arytenoideus transversus* is an unpaired muscle. It is composed of transverse fibres which bridge across the interval between the two arytenoid cartilages, and are attached to the posterior concave surfaces of both of these cartilages.

Dissection.—The further dissection of the laryngeal muscles should be confined to the right side of the larynx. The left side should be reserved for the study of the nerves and vessels. Place the larynx on its left side, and, having fixed it in this position, remove the right crico-thyroid muscle. The right lateral thyro-hyoid ligament should next be divided, and the right inferior cornu of the thyroid cartilage disarticulated from its facet on the side of the cricoid cartilage. An incision should now be made through the right ala of the thyroid cartilage a short distance to the outer side of the mesial plane, and the detached piece carefully removed. Three muscles are now exposed, and must be carefully cleaned and defined. They are named from below upwards :—

1. The lateral crico-arytenoid.
2. The thyro-arytenoid.
3. The thyro-epiglottidean.

The Lateral Crico-arytenoid Muscle is triangular in form, and smaller than the crico-arytenoideus posticus. It springs from the upper border of the lateral part of the cricoid cartilage as far back as the facet which supports the base of the arytenoid cartilage; a few of its fibres likewise take origin

from the crico-thyroid membrane. From this attachment its fibres run backwards and upwards, and converge to be inserted into the anterior surface and lower border of the processus muscularis or outer projecting angle of the base of the arytenoid cartilage. The superficial or outer surface of this muscle is covered by the ala of the thyroid cartilage and the upper part of the crico-thyroid muscle; its deep surface is applied to the lateral part of the crico-thyroid membrane.

Thyro - arytenoid Muscle. — This is a muscular sheet which is placed above the crico-arytenoideus lateralis. The contiguous margins of these muscles are sometimes found so intimately blended that it is impossible to effect a natural separation.

The thyro-arytenoid muscle is usually described as consisting of a superficial and a deep portion, termed respectively the thyro-arytenoideus externus and internus. Whilst we adopt this subdivision for convenience in description, it is necessary to state that it is not a natural one, seeing that the two parts are as a general rule inseparably united, and can only be isolated from each other by artificial means.

The *thyro-arytenoideus externus* is a broad muscular layer which lies immediately subjacent to the ala of the thyroid cartilage. Its lower border is in contact with the lateral crico-arytenoid muscle, whilst its upper border is placed at a higher level than the true vocal cord. Its upper part, therefore, is in relation to the wall of the laryngeal sinus. The thyro-arytenoideus externus arises in front from the lower half of the inner surface of the ala of the thyroid cartilage, close to the angle, and also from the crico-thyroid membrane. Its fibres pass backwards and are inserted into the outer border and muscular process of the arytenoid cartilage. A certain proportion of its uppermost fibres curve upwards and backwards to reach the epiglottis. These constitute the *thyro-epiglottidean muscle.*

The *thyro-arytenoideus internus* is a slender three-sided muscular band which is closely applied to the outer side of

the true vocal cord, and receives its prismatic form from this adaptation. It arises in front from the angular depression between the two alæ of the thyroid cartilage, and is inserted behind into the outer aspect of the processus vocalis, and also into the adjoining part of the antero-external surface of the arytenoid cartilage.

The thyro-arytenoideus internus is thicker behind than in front. This is due to the fact that whilst all the fibres which compose it are attached to the arytenoid cartilage, only a certain proportion obtain attachment to the thyroid cartilage. A large number of the deeper fibres are directly attached at different points to the outer side of the true vocal cord. These constitute the *ary-vocalis muscle* (Ludwig).

A muscle termed the *thyro-arytenoideus superior* is frequently present. It is a slender band which arises from the inner aspect of the ala of the thyroid cartilage close to the notch, and passes backwards and downwards to find insertion into the lateral border of the arytenoid cartilage immediately above the processus muscularis.

The Thyro-ary-epiglottidean Muscle is composed of fibres derived from the arytenoideus obliquus and the thyro-arytenoideus externus. The two parts of the muscle meet in the upper part of the aryteno-epiglottidean fold of mucous membrane, and are inserted into the margin of the epiglottis.

Dissection.—The lateral crico-arytenoid muscle should now be carefully removed, and at the same time the dissector should endeavour to disengage the fibres of the thyro-arytenoideus externus from the deeper thyro-arytenoideus internus, in order that its relation to the true vocal cord may be studied. Finally remove the entire thyro-arytenoid muscle. This will display the outer surface of the lateral part of the crico-thyroid membrane, the true vocal cord or inferior thyro-arytenoid ligament, and the wall of the laryngeal sinus. By carefully dissecting between the two layers of mucous membrane which clothe the false vocal cord, the weak superior thyro-arytenoid ligament which gives it support may be discovered, as well as a number of racemose glands which lie in relation to it.

Lateral part of the Crico-thyroid Membrane.—The central part of the crico-thyroid membrane, as we have noted,

closes in front the interval between the cricoid and thyroid cartilages. On each side, however, the lateral part of the same membrane is not attached to the lower border of the thyroid cartilage, but slopes upwards and inwards, and very materially diminishes the transverse width of the lower subdivision of the laryngeal cavity in its upper part. The attachments which it effects are very definite. *Below* it is fixed to the upper border of the cricoid cartilage, immediately subjacent to the mucous membrane; *in front* it is attached to the lower half of the inner surface of the ala of the thyroid cartilage, close to the angle; and *behind* to the lower border of the processus vocalis of the arytenoid cartilage. *Above* it is directly continuous with the *inferior thyro-arytenoid ligament* or true vocal cord. The latter, indeed, may be looked upon as constituting its upper, thickened, free border. In contact with its outer surface are the lateral crico-arytenoid and the thyro-arytenoid muscles, whilst its inner surface is clothed by the lining mucous membrane of the larynx.

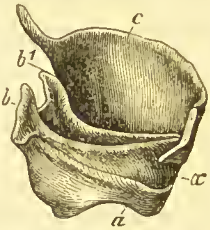


FIG. 268.—Diagram to show the connections of the crico-thyroid membrane. (From AEBY.)

a. Cricoid cartilage.
b, *b'*. The two arytenoid cartilages.
c. Thyroid cartilage. The right ala has been removed.
α. Crico-thyroid membrane. The extension upwards of its two lateral parts to form the true vocal cords is seen.

The Inferior Thyro-arytenoid Ligament or true vocal cord is formed in connection with the upper free border of the lateral part of the crico-thyroid membrane. It is attached in front, close to its fellow of the opposite side, to the middle of the angular depression between the two alæ of the thyroid cartilage. From this it stretches backwards, and is fixed behind to the tip and upper border of the processus vocalis, which projects forwards from the base of the arytenoid cartilage. The inferior thyro-arytenoid liga-

ment is composed of yellow elastic fibres, and measures from its anterior attachment to the point of the processus vocalis from 14 to 16 m.m. in the male, and from 9 to 11 m.m. in the female (Krause). Its inner border is sharp and free, and is clothed by mucous membrane, which in this position is thin and firmly bound down to the ligament. Embedded in its anterior extremity there is a minute nodule of condensed elastic tissue.

By removing the mucous membrane which lines the bottom of the laryngeal sinus the dissector will obtain a good view of the parts which bound the rima glottidis—viz., *in front*, the angle of the thyroid cartilage; *behind*, the arytenoideus transversus muscle; *on each side*, the inferior thyro-arytenoid ligament, the processus vocalis, and the inner surface of the arytenoid cartilage (p. 468). These parts are clothed by the lining mucous membrane of the larynx.

The Superior Thyro-arytenoid Ligament supports the false vocal cord. It is weak and indefinite, but somewhat longer than the preceding ligament. In front it is attached to the angular depression between the two alæ of the thyroid cartilage, above the true vocal cords, and immediately below the attachment of the thyro-epiglottidean ligament, and extends backwards to be fixed to a tubercle on the antero-external surface of the arytenoid cartilage above the processus vocalis. It is composed of connective tissue and elastic fibres, which are continuous with the fibrous tissue in the aryteno-epiglottidean fold.

Dissection.—Remove the remains of the aryteno-epiglottidean fold, the vocal cords, and the lateral part of the crico-thyroid membrane on the right side of the larynx, but be careful not to injure the arytenoid cartilage and the cartilage of Santorini. Should the cuneiform cartilage be present in the aryteno-epiglottidean fold it should be detached and preserved. By this dissection a closer view of the side wall of the laryngeal cavity can be obtained. The undissected vocal cords of the left side should again be examined, the laryngeal sinus and pouch explored, and their precise connections and extent determined. When

the student has satisfied himself upon these points he can proceed to display the vessels and nerves of the larynx. The superior laryngeal artery and the internal larnygeal nerve reach the larynx by piercing the outer thin part of the thyro-hyoid membrane. By applying traction to the nerve, and at the same time dividing the mucous membrane upon the inner surface of the thyro-hyoid ligament, they can easily be discovered. In following the branches into which they divide the mucous membrane must be gradually removed from the inner wall of the larynx. The inferior laryngeal artery and nerve enter from below, and proceed upwards, under cover of the ala of the thyroid cartilage. They can only be satisfactorily displayed by the removal of this piece of cartilage, but the dissector is not recommended to adopt this method unless another larynx is available for the examination of the cartilages and joints. By drawing the thyroid cartilage well outwards the more important branches can be studied.

The Internal Laryngeal Nerve.—In the dissection of the neck this nerve has been observed to arise from the superior laryngeal branch of the vagus. It is a sensory nerve, and its branches are chiefly distributed to the mucous membrane of the larynx. Piercing the lateral part of the thyro-hyoid ligament it divides into three branches. The *uppermost* of these sends filaments to the aryteno-epiglottidean fold, to the mucous membrane which covers the epiglottis, and to the glosso-epiglottidean folds. The twigs which go to the epiglottis ramify on its posterior surface, but many of them pierce the cartilage to reach the mucous membrane on its anterior surface. The *intermediate* branch of the internal laryngeal nerve breaks up into filaments which are given to the mucous membrane lining the side wall of the larynx. The *lowest branch* descends and gives filaments to the mucous membrane which covers the outer and back aspects of the arytenoid and cricoid cartilages. A well-marked twig proceeds from this branch and runs downwards upon the posterior aspect of the cricoid cartilage to join the recurrent laryngeal nerve.

The Recurrent Laryngeal Nerve has previously been seen to arise from the vagus, and it has been traced in the neck up to the point where it disappears under cover of the lower

border of the inferior constrictor muscle. It now is observed to ascend upon the outer aspect of the cricoid cartilage, immediately behind the crico-thyroid joint. Here it is joined by the communicating twig from the internal laryngeal nerve, and almost immediately afterwards it divides into two branches. The *larger* of these proceeds upwards, under cover of the ala of the thyroid cartilage, and breaks up into filaments which supply the lateral crico-arytenoid, the thyro-arytenoid, and the thyro-ary-epiglottidean muscles; the *smaller* or *posterior* branch inclines upwards and backwards upon the posterior aspect of the cricoid cartilage, and under cover of the posterior crico-arytenoid muscle. It supplies twigs to this muscle, and is then continued onwards to end in the arytenoid muscle.

The recurrent laryngeal nerve is therefore the motor nerve of the larynx. It supplies all the muscles with the exception of the crico-thyroid, which draws its nerve-supply from the external laryngeal. The recurrent laryngeal nerve, however, is usually considered to contain a few sensory fibres. These it gives to the mucous membrane of the larynx below the rima glottidis.

Laryngeal Arteries.—The *superior laryngeal artery*, a branch of the superior thyroid, accompanies the internal laryngeal nerve; the *inferior laryngeal artery* which springs from the inferior thyroid accompanies the recurrent laryngeal nerve. These two vessels ramify in the laryngeal wall and supply the mucous membrane, glands and muscles.

Laryngeal Cartilages and Joints.—The cartilages which constitute the skeleton of the larynx and give support to its wall are the following:—

1. Thyroid, 2. Cricoid, 3. Epiglottis,	single.	4. Arytenoid, 5. Cornicula laryngis or cartilages of Santorini, 6. Cuneiform,	paired.

They are held together by certain ligaments and joints.

Dissection.—The mucous membrane and muscles must be carefully removed from the cartilages, and the epiglottidean, crico-thyroid, and crico-arytenoid ligaments defined. Great caution must be exercised in cleaning the arytenoid cartilages and the cartilages of Santorini, in order that the slender ligaments which attach the latter to the upper border of the cricoid cartilage may be preserved (Fig. 270, p. 467).

The Epiglottis is a thin leaf-like lamina of yellow fibro-cartilage placed behind the root of the tongue and in front of the superior opening of the larynx. When divested of the mucous membrane which covers it, it will be seen to present a somewhat heart-shaped form, and to be indented by deep pits and numerous perforations in which glands are lodged. Its broad end is directed upwards and is free; its margins are almost completely enclosed within the aryteno-epiglottidean folds. The anterior surface is only free in its upper part; below, it is in relation to the thyro-hyoid ligament, from which, however, it is separated by adipose tissue and some mucous glands. The posterior surface is free in all its extent and bounds the vestibule of the larynx in front.

Epiglottidean Ligaments.—The epiglottis is bound by ligaments to the root of the tongue, to the hyoid bone, and to the thyroid cartilage. The three *glosso-epiglottidean folds* have already been studied. In each there is a small quantity of elastic tissue. The *hyo-epiglottidean ligament* is a short, broad elastic band which connects the anterior face of the epiglottis to the upper border of the body of the hyoid bone. The *thyro-epiglottidean ligament* is strong, elastic and thick. It proceeds downwards from the lower pointed extremity of the epiglottis, and is attached to the angular depression between the two alæ of the thyroid cartilage, below and behind the median notch.

The Thyroid is the largest of the laryngeal cartilages. It is composed of two broad somewhat quadrilateral plates, termed the *alæ*, which meet in front at an acute angle and constitute the projection in the neck known as the *pomum*

Adami. This is more prominent in its upper part than below, and is always more marked in the male than in the female. From the pomum Adami the two alæ diverge backwards and outwards, like the limbs of the letter V, so as to enclose between them the posterior lamina of the cricoid cartilage and the arytenoid cartilages. The *upper border* of each ala is somewhat convex, but in front it is cut away or bevelled off, so that with the corresponding part of the opposite ala a deep median notch is formed. This is called the *incisura thyroidea.* The *lower border* is nearly straight, but is subdivided by a slight tubercle into an anterior and a posterior concave part. The *posterior border* is thick and rounded and gives attachment to the fibres of the stylo-pharyngeus and palato-pharyngeus muscles. Above and below this border projects in the form of prominent processes. These are termed the *cornua.* The *superior cornu* is longer than the inferior cornu, and gives attachment to the lateral thyro-hyoid ligament. The shorter, stronger *inferior cornu* curves slightly inwards. On the inner aspect of its tip there is a facet which articulates with the side of the cricoid cartilage. The *outer surface* of the ala is flat.

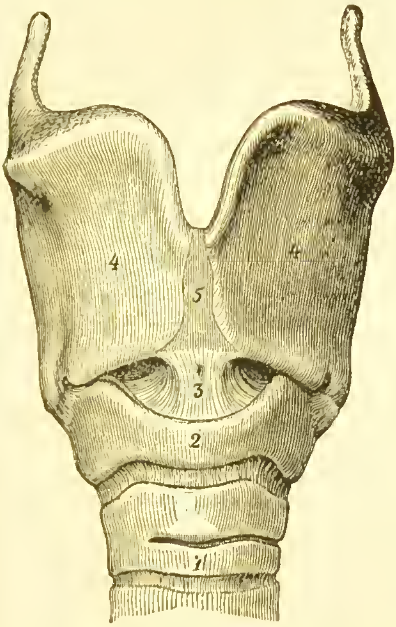


FIG. 269.—Cartilages of larynx seen from the front. (From LUSCHKA.)

1. Trachea.
2. Cricoid cartilage.
3. Central part of crico-thyroid membrane.
4. Alæ of thyroid cartilage.
5. Intermediate lamina. This is a part of the cartilage which is more or less distinct from the alæ and connects them at the pomum Adami. It is not described in the text.

Immediately below the posterior part of the upper border and in front of the root of the superior cornu there is a distinct tubercle. From this an oblique ridge descends towards the tubercle on the lower border of the ala. It gives attachment to the sterno-thyroid and thyro-hyoid muscles, and divides the outer surface of the ala into an anterior and a posterior part. To the latter, which is much the smaller of the two, is attached the inferior constrictor muscle of the pharynx. The *inner surface* of the ala is smooth and slightly concave. To the angular depression between the two alæ are attached the thyro-epiglottidean ligament, the superior thyro-arytenoid ligaments, and the inferior thyro-arytenoid ligaments.

The Crico-thyroid Joint, or the articulation on each side between the tip of the inferior cornu of the thyroid cartilage, and the side of the cricoid cartilage, belongs to the diarthrodial variety. The opposed surfaces are surrounded by a capsular ligament which is lined by a synovial membrane. The movements which take place at these joints are of a two-fold character—viz. (1) gliding; (2) rotatory. In the case of the former the two opposed surfaces glide upon each other in different directions. The rotatory movement is one around a transverse axis which passes through the centre of each joint. The capsular ligament is strengthened by a stout band on the posterior aspect of the joint.

The thyroid cartilage should now be removed by dividing the ligaments which surround the crico-thyroid joint.

The Cricoid Cartilage is shaped like a signet ring. The broad *posterior lamina* is somewhat quadrilateral in form. Its superior border presents a faintly marked mesial notch, and on each side of this there is an oval convex facet which articulates with the base of the arytenoid cartilage. The posterior surface of the lamina is divided by an elevated median ridge, into two slightly hollowed out areas which give attachment to the posterior crico-arytenoid muscles.

The mesial ridge itself gives origin to the fibres which form the anterior longitudinal muscular band of the œsophagus. In front of the posterior lamina, the ring of the cricoid cartilage is completed by an *anterior arch.* The lower border of this is horizontal, and is connected to the first tracheal ring by membrane. The arch is narrow in front, and is attached to the lower border of the thyroid cartilage by the middle portion of the crico-thyroid membrane. Behind this the upper border rapidly ascends. Upon the posterior part of the lateral surface of the cricoid cartilage there is a circular, slightly elevated, convex facet, which looks outwards and upwards for articulation with the inferior cornu of the thyroid cartilage. Internally the cricoid cartilage is lined by mucous membrane. Inferiorly the lumen is circular, but above it is elliptical.

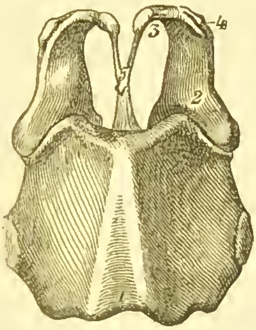


FIG. 270.—Posterior view of the cricoid and arytenoid cartilages. (From LUSCHKA.)

1. Posterior lamina of cricoid cartilage.
2. Arytenoid cartilage.
3. Cartilage of Santorini.
4. Sesamoid cartilage.
5. Ligamentum jugale.

Cartilages of Santorini (*cornicula laryngis*).—Before proceeding to the study of the arytenoid cartilages the dissector should examine the cartilages of Santorini and the manner in which they are held in position. They are two minute pyramidal nodules of yellow elastic cartilage which are placed on the summits of the arytenoid cartilages, and are directed backwards and inwards. Each cartilage of Santorini is enclosed within the corresponding aryteno-epiglottidean fold of mucous membrane, and is joined to the apex of the arytenoid cartilage by a joint which may either partake of the nature of diarthrosis or synchondrosis. The tips of the two cornicula laryngis are connected to

the upper border of the posterior lamina of the cricoid cartilage by a Y-shaped ligament, termed the *ligamentum jugale.*

Arytenoid Cartilages.—In dealing with the arytenoid cartilages it is well to remove one in order that its external form may be studied; the other should be retained in position for the purpose of afterwards examining the crico-arytenoid joint, and the movements which can be performed at this articulation.

The *arytenoid cartilages* are pyramidal in form, and surmount the upper border of the posterior lamina of the cricoid cartilage. The *apex* of each is directed upwards, and at the same time curved backwards and inwards. It supports the cartilage of Santorini. Of the three surfaces, one looks directly inwards towards the corresponding surface of the opposite cartilage, from which it is separated by a narrow interval; another looks backwards; whilst the third is directed outwards and forwards. The *internal surface* is narrow, vertical and even, and is clothed by mucous membrane. The *posterior surface* is concave; it lodges and gives attachment to the arytenoideus transversus muscle. The *antero-external* surface is the most extensive of the three, and is uneven for muscular and ligamentous attachments. Upon this aspect of the arytenoid cartilage the thyro-arytenoid muscle is inserted, whilst a small tubercle placed a short distance above the base gives attachment to the superior thyro-arytenoid ligament—the supporting ligament of the false vocal cord. The surfaces of the arytenoid cartilage are separated by three borders, viz., an anterior, a posterior, and an external. The *external border* is the longest, and at the base of the cartilage it is prolonged outwards and backwards in the form of a stout prominent angle or process, termed the *processus muscularis.* Into the front of this the crico-arytenoideus lateralis muscle is inserted; into its posterior aspect the crico-arytenoideus posticus muscle is inserted. Near the apex of the arytenoid

cartilage a small nodule of yellow elastic cartilage is frequently placed upon the external border, and is held in this position by the investing perichondrium. It is termed the *sesamoid cartilage.* The *anterior border* of the arytenoid cartilage is prolonged into the projecting anterior angle of the base. This is called the *processus vocalis.* It is sharp and pointed, is directed horizontally forwards, and gives attachment to the inferior thyro-arytenoid ligament or true vocal cord. The *base* of the arytenoid cartilage presents an elongated concave facet on its under aspect for articulation with the upper border of the posterior lamina of the cricoid cartilage.

The Crico-arytenoid Articulation is of the diarthrodial variety. There is a distinct joint cavity surrounded by a capsular ligament which is lined by a synovial membrane. The cricoid articular surface is convex, that of the arytenoid concave; both are elongated in form, but they are placed in relation to each other, so that the long axis of the one intersects or crosses that of the other, and in no position of the joint do the two surfaces accurately coincide; a portion of the cricoid surface is always left uncovered. The movements allowed at this joint, as the dissector can readily determine, are of a two-fold kind—(1) *gliding*, by which the arytenoid is carried inwards or outwards, or, in other words, a movement by which the arytenoid advances towards or retreats from its fellow; (2) *rotatory*, by which the arytenoid cartilage revolves round a vertical axis. By this movement the vocal process is swung outwards or inwards, so as to open or close the rima glottidis.

The dissector should note that the capsule of this joint is strengthened behind by a strong band which plays a most important part in the mechanism of the articulation. It acts in such a manner that it arrests forward movement of the arytenoid cartilage.

The Cuneiform Cartilages are two little conical nodules of yellow elastic cartilage, which are placed one in each

aryteno-epiglottidean fold near its back part. They are not always present.

Action of the Laryngeal Muscles.—The dissector should now consider the manner in which the muscles of the larynx operate upon the true vocal cords in the production of the voice. *Tension* of the vocal cords is effected by the contraction of the *crico-thyroid muscles.* In this action the thyroid cartilage is more or less fixed. The oblique parts of the muscles raise the anterior arch of the cricoid cartilage, which causes the upper border of its posterior lamina with the arytenoid cartilages to pass backwards and downwards. At the same time the posterior horizontal parts of the muscles tend through their insertion into the inferior cornua to draw the thyroid cartilage forwards. When the crico-thyroid muscles cease to contract, the relaxation of the cords is brought about by the elasticity of the ligaments. The *thyro-arytenoid muscles* must be regarded as antagonistic to the crico-thyroid muscles. When they contract, they draw forward the arytenoid cartilages and posterior lamina of the cricoid cartilage, and still further relax the cords, and when they cease to act, the elastic ligaments again bring about a state of equilibrium. The *ary-vocales* muscles, by the insertion of their fibres into the true vocal cords, may tighten portions of the cords, and, at the same time, relax the parts behind.

The *width* of the rima glottidis is affected by the arytenoideus, which approximates the arytenoid cartilages and by the crico-arytenoidei laterales and postici. The *crico-arytenoidei postici*, by drawing the muscular processes of the arytenoid cartilages outwards and backwards, swing the processus vocales and the vocal cords outwards, and thus open the rima. The *crico-arytenoidei laterales* are antagonistic muscles, and by drawing the muscular processes in an opposite direction, close the rima.

But the muscles of the larynx have another function to perform besides that of vocalisation. It was formerly thought that the superior aperture of the larynx was closed during deglutition by the folding back of the epiglottis; that in fact the epiglottis, during the passage of the bolus of food, was applied like a lid over the entrance to the vestibule of the larynx. This view is now known to be erroneous. The investigations of Prof. Anderson Stuart have shown that the superior aperture of the larynx is closed during swallowing by the close application and the forward folding of the two arytenoid cartilages, so that their apices become closely applied to the cushion of the epiglottis. The muscles chiefly concerned in this movement are the external thyro-arytenoid muscles and the transverse arytenoid muscle. These muscles form a true sphincter vestibuli. The thyro-ary-epiglottidean muscle also assists in the closure.

THE TONGUE.

The tongue is a muscular organ placed on the floor of the mouth. It has important duties to perform in connection with the functions of mastication, deglutition, and articulation. Moreover, the mucous membrane which covers it is specially modified in certain localities in connection with the peripheral terminations of the nerves of taste. The root, or broad posterior extremity of the tongue, is attached to the hyoid bone; in front, the pointed extremity is free. The dorsal aspect of its base forms the lower boundary of the isthmus faucium, and is surmounted on each side by the tonsil.

Mucous Membrane.—The lingual mucous membrane is a part of the general mucous lining of the buccal cavity, and it envelops the dorsum, sides, tip, and under surface of the tongue. It presents different appearances in different localities. Thus over the posterior part of the dorsum, in the region which is bounded behind by the epiglottis, and on either side by the tonsil, the mucous membrane is smooth, and presents no papillæ which are visible to the unaided eye. It is from this district that the three glosso-epiglottidean folds take origin, and every here and there the surface is studded with low projections which are produced by lymphoid follicles, placed subjacent to the mucous membrane. About an inch or so in front of the epiglottis, a median depression, termed the *foramen cæcum*, may be noticed, and in front of this the mucous membrane which covers the dorsum, sides, and tip of the tongue is beset with papillæ of different kinds. As these are individually visible to the naked eye, the mucous membrane presents a very characteristic appearance. Further a mesial groove or sulcus called the *raphe*, extends backwards from the tip of the tongue to the foramen cæcum, and divides the anterior two-thirds of the dorsum into two lateral parts.

On the under surface of the tongue the mucous membrane is smooth and comparatively thin. In the mesial plane it forms the *frænum linguæ*, which has been studied at an earlier stage. On either side of the median line the lingual vein may be noticed in the living subject stretching forwards towards the tip. To the outer side of this, and, therefore, somewhat nearer the border of the tongue, is a delicate and feebly marked fold of mucous membrane, from the free border of which a row of fringe-like processes or fimbriæ project. It is termed the *plica fimbriata*, and as it extends forwards towards the tip of the tongue, it inclines towards the mesial plane and its neighbour of the opposite side (Fig. 238, p. 327). On the side of the tongue, immediately in front of the lingual attachment of the anterior pillar of the fauces, five short vertical fissures in the mucous membrane separated by intervening folds may be noticed. This arrangement is termed the *papilla foliata*. It is the representative of a leaf-like condition of the mucous membrane, which is much more highly developed in certain of the lower animals (hare and rabbit), and which is specially concerned in receiving the impressions of taste.

The Lingual Papillæ are of three kinds, and differ in size, shape, and in the position they occupy on the surface of the tongue. They are termed the circumvallate, the fungiform, and the conical.

The *circumvallate papillæ* are the largest, and are placed on the posterior part of the dorsum in two rows, which diverge from each other in an outward and forward direction, like the two limbs of the letter V. The foramen cæcum forms the apex of the V, and the papillæ vary in number from seven to twelve. In form a circumvallate papilla is broad and somewhat cylindrical, slightly narrower at its attached than at its free extremity, and sunk in a pit. It is surrounded by a deep trench, the walls of which are slightly raised beyond the general surface of the mucous membrane. The free extremity of each papilla is therefore

encircled by an annular elevation, which is termed the *vallum.*

The *fungiform papillæ* are much smaller, but are present in much greater numbers. They are chiefly found on the tip and sides of the tongue, but they are also scattered at irregular intervals over the dorsum. They are very characteristic in form. Each papilla presents a large, full, rounded knob-like extremity, while it is greatly constricted at the point where it springs from the mucous surface. In the living tongue the fungiform papillæ are distinguished by their bright red colour.

The *conical papillæ* are present in very large numbers. They are smaller than the fungiform variety, and although they are quite visible to the naked eye, they can be more conveniently studied by the aid of an ordinary pocket lens. They are minute conical projections from the mucous membrane which taper towards their free extremities, and occupy the dorsum and sides of the tongue in front of the foramen cæcum. They are arranged in parallel rows which are placed close together, and in the back part of the tongue these diverge from the mesial raphe in a forward and outward direction. Towards the tip of the tongue the rows of conical papillæ become more or less transverse in direction, and on the sides of the tongue they are arranged perpendicularly.

Muscles of the Tongue.—The tongue is almost entirely composed of muscular fibres, with some adipose tissue intermixed. It is divided into two lateral halves by a mesial septum, and the muscles in connection with each of these consist of an intrinsic and an extrinsic group. They are as follows:—

Extrinsic Muscles,
1. Genio-hyo-glossus.
2. Hyo-glossus.
3. Chondro-glossus.
4. Stylo-glossus.
5. Palato-glossus.

Intrinsic Muscles,
1. Superficial lingual.
2. Inferior lingual.
3. Vertical.
4. Transverse.

The extrinsic muscles take origin from parts outside the tongue, and thus are not only capable of giving rise to changes in the form of the organ, but also of producing changes in its position. The intrinsic muscles, which are placed entirely within the substance of the tongue, are, for

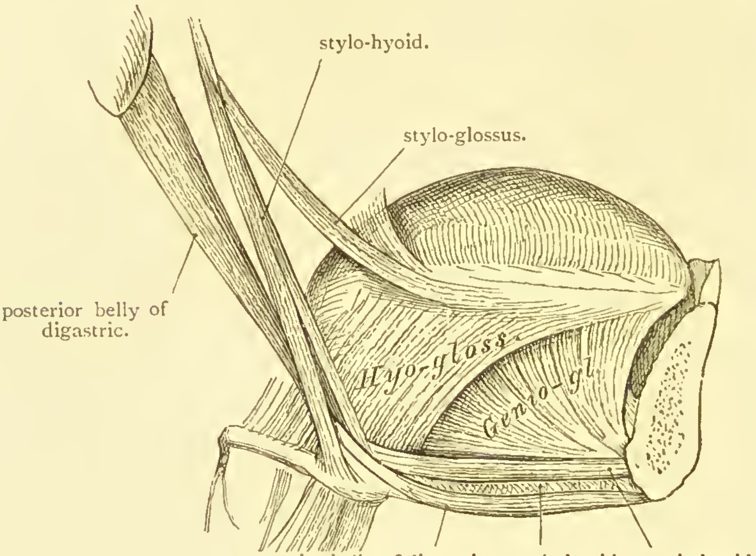


FIG. 271.—Muscles of the tongue. (From GEGENBAUR.)

the most part, only capable of giving rise to alterations in its form.

With the exception of the chondro-glossus, the extrinsic muscles have already been studied, but the dissector should take this opportunity of examining more fully their insertions, and the manner in which their fibres are related to each other, and to those of the intrinsic muscles. For this purpose, carefully reflect the mucous membrane from the right half of the tongue, and follow the muscles into that side of the organ. At the same time the lingual nerves and the ranine artery should be preserved. On the under surface of the tongue near the tip, the removal of

the mucous membrane will expose a group of glands aggregated together, so as to form a small oval mass on each side of the mesial plane.

The *stylo-glossus* will be observed to run along the side of the tongue to the tip where the two muscles become to a certain extent continuous. The *hyo-glossus* extends upwards to the side of the tongue, and its fibres pass for the most part under cover of those of the stylo-glossus to reach the dorsum, over the posterior part of which they spread out beneath the mucous membrane. The *genio-hyo-glossus* sends its fibres vertically upwards into the tongue on each side of the mesial septum, and its insertion stretches from the tip to the base. The fibres of the *palato-glossus* become continuous with those which form the stratum transversum.

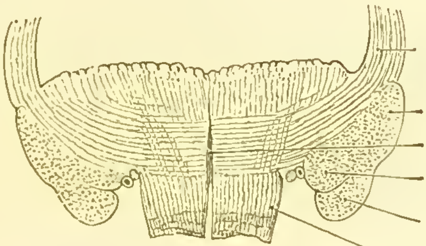


FIG. 272.—Transverse section through the hinder part of the tongue. (From GEGENBAUR.)

The *chondro-glossus* is not always present. It is separated from the deep surface of the hyo-glossus by the lingual vessels, and by the pharyngeal slip of the genio-hyo-glossus. It is a slender muscular band which takes origin from the inner aspect of the root of the lesser cornu, and the adjoining part of the body of the hyoid bone. Its fibres ascend to enter the tongue, and finally spread out on the dorsum under cover of the lingualis superior.

The *superficial lingual muscle* (lingualis superior) is a continuous layer of longitudinal fibres which covers the entire dorsum linguæ, from the root to the tip, immediately beneath the mucous membrane. Towards the base of the

tongue it is thinner than in front, and here it is overlapped by the transverse fibres of the hyo-glossus, and is intermixed with the fibres of the chondro-glossus.

The *inferior lingual muscle* (lingualis inferior) is a rounded fleshy belly which is placed upon the inferior aspect of the tongue. Behind, it lies in the interval between the hyo-glossus and the genio-hyo-glossus and shows an attachment to the hyoid bone ; in front, it is prolonged to the apex of the tongue between the inner border of the stylo-glossus and the genio-hyo-glossus ; with the former it is more or less blended.

The *transverse muscular fibres* (stratum transversum) lie

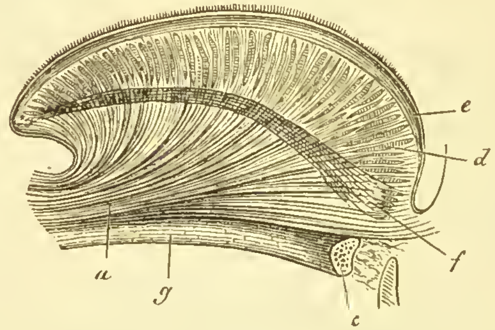


FIG. 273.—Longitudinal section through the tongue. (From AEBY.)

c. Lingualis superior.	*g.* Genio-hyoid.
f. Lingualis inferior.	*a.* Genio-hyo-glossus.
d. Lamellæ of stratum transversum.	*c.* Hyoid bone.

under the lingualis superior, and constitute a thick layer which extends outwards from the lateral face of the septum linguæ, to reach the dorsum and side of the tongue. The fibres of the genio-hyo-glossus ascend through the stratum transversum and break it up into numerous lamellæ (Fig. 273 *d*). It is joined by the fibres of the palato-glossus (Henle) (Fig. 272).

The *vertical muscular fibres* (stratum perpendiculare) extend in a curved direction from the dorsum to the under

aspect of the tongue, and decussate with the fibres of the stratum transversum.

Nerves and Vessels of the Tongue.—The nerves of the tongue are—(1) the glosso-pharyngeal; (2) the lingual; (3) the hypoglossal; and (4) a few twigs from the internal laryngeal. These should be traced on the left side of the tongue, where the mucous membrane is still in position.

The *glosso-pharyngeal nerve* has been traced up to the point where it disappears under cover of the hyo-glossus muscle. Here it divides into two branches. The *smaller* of these extends forwards upon the side of the tongue, and may be traced as far as a point midway between the root and the tip. The *larger* branch turns upwards and is distributed to the mucous membrane which invests the posterior third of the dorsum linguæ. It gives twigs to the circumvallate papillæ, and some fine filaments may be followed to the anterior surface of the epiglottis. The glosso-pharyngeal nerve is the principal nerve of taste.

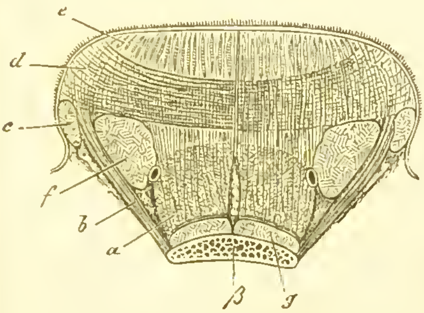


FIG. 274.—Transverse section through the tongue. (From AEBY.)

a. Genio-glossus.
b. Hyo-glossus.
c. Stylo-glossus.
d. Stratum transversum.
e. Lingualis superior.
f. Lingualis inferior.
g. Genio-hyoid.
β. Hyoid bone.

The *lingual* and *hypoglossal nerves* are described in pages 328 and 329, and their terminal branches should now be traced as far as it is possible to do so.

The *internal laryngeal nerve* gives a few delicate filaments to the glosso-epiglottidean folds and the mucous membrane of the root of the tongue.

The *ranine artery* should be followed to the tip of the

tongue, where it forms a small loop of anastomosis with its fellow of the opposite side (p. 332).

Septum Linguæ.—The septum of the tongue can best be seen by making a transverse section through the organ. This will also in a measure demonstrate the stratum transversum and stratum perpendiculare of muscular fibres. The septum is a mesially placed fibrous partition. It is strongest behind, where it is attached to the hyoid bone.

THE BRAIN.

Directions.—In the first instance the brain should be placed on a dissecting-room platter, with its superior surface uppermost. As it has in all probability been removed from strong spirit, it is necessary to keep it moist during the whole dissection, by means of a cloth dipped in water. Unless this be done the membranes are apt to become dry, and then they are exceedingly difficult to remove.

General Appearance of the Brain.—When viewed from above the brain presents an ovoid figure, its broad end being directed backwards. Its greatest transverse diameter is in the neighbourhood of the parietal eminences. The only parts which are visible when the brain is in this position are the two convoluted cerebral hemispheres. These are separated from each other by a deep mesial cleft, called the great longitudinal fissure, which extends from the front to the back of the brain.

The position of the brain should now be reversed. Turn it so that it rests on its superior surface.

The inferior aspect of the brain is usually termed the "base." It presents an uneven and irregular surface, which is more or less accurately adapted to the inequalities on the floor of the cranium. From this point of view some of the main subdivisions of the organ may be recognised. Thus, behind is seen the short cylindrical portion, called

the *medulla oblongata* or *bulb*, through which, at the foramen magnum, the brain becomes continuous with the spinal cord. The bulb rests on the under surface of the cerebellum, being received into the vallecula or hollow which intervenes between the two cerebellar hemispheres. The *cerebellum* is a mass of considerable size which lies under

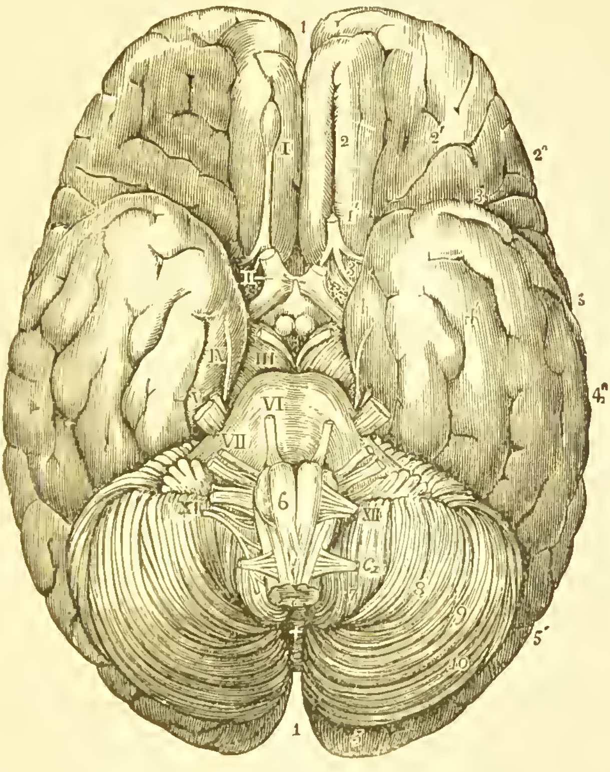


FIG. 275.—The base of the brain.

1. The great longitudinal fissure.
I. Olfactory tract and bulb.
II. lies on anterior perforated spot, and points to the optic nerve.
III. is placed on the crus cerebri, immediately to the outer side of the oculomotor nerve.
IV. Trochlear nerve.
V. Trigeminal nerve.
VI. is placed on the pons Varolii, immediately in front of the abducent nerve.
VII. is placed on the middle peduncle of the cerebellum, in front of the facial and auditory nerves.
XI. Spinal accessory nerve.
XII. Hypoglossal nerve.
C. 1. First cervical nerve.
6. Medulla oblongata.

the hinder portions of the cerebral hemispheres. It can be easily recognised on account of the closely-set, curved and parallel fissures which traverse its surface. Above the medulla, and in direct connection with it, is a prominent white elevation called the *pons Varolii.* The basilar artery extends upwards in a mesial groove on its surface. Immediately in front of the pons Varolii there is a deep hollow or recess. This is bounded behind by the pons, on either side by the projecting temporal lobes of the cerebrum, and in front by the orbital portions of the frontal lobes of the cerebrum. At the present stage of the examination of the brain, the bottom of this hollow is hidden from view by the arachnoid mater, which stretches over it like a veil; but if the pituitary body has been removed with the brain it will be seen within its limits. Passing out from either side of the fore part of this recess will be seen the deep Sylvian fissure, which intervenes between the pointed and projecting extremity of the temporal lobe and the frontal lobe of the cerebrum, whilst in the middle line in front the great longitudinal fissure will be observed to separate the frontal portions of the cerebral hemispheres. On either side of the great longitudinal fissure, and separated from it by a narrow gyrus, the olfactory peduncle and bulb may be recognised.

MEMBRANES AND BLOOD VESSELS OF THE BRAIN.

Arachnoid Mater.—This forms the intermediate covering of the brain. Placed between the dura mater and the pia mater it is directly continuous with the arachnoidea of the spinal cord. It is an exceedingly thin and delicate membrane, which can best be seen on the base of the brain, as in this locality it is not so closely applied to the pia mater as elsewhere. Unlike the pia mater, it does not (except in the case of the great longitudinal and the Sylvian fissures)

dip into the sulci on the surface of the cerebrum and cerebellum. It bridges over the inequalities on the surface of the brain. It is consequently spread out in the form of a very distinct sheet over the medulla, the pons Varolii, and the hollow on the base of the brain which lies in front of the pons. The cut ends of several of the cranial nerves will be observed projecting through this sheet; whilst in front, immediately to the outer side of the optic nerve, the internal carotid artery may be noticed piercing it.

Subarachnoid Space.—The interval between the arachnoidea and the pia mater receives the name of the sub-

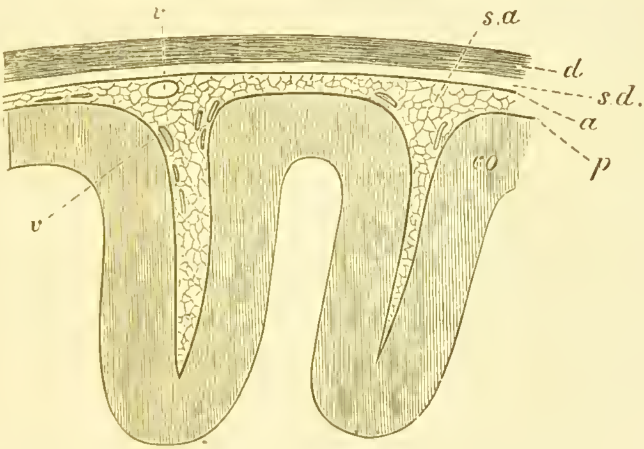


Fig. 276.—Diagram of the meninges of the brain.

arachnoid space. It contains the subarachnoid fluid, and is broken up by a meshwork of fine filaments and trabeculæ, which connects the two bounding membranes in the most intimate manner, and forms a delicate sponge-like interlacement between them. Where the arachnoidea passes over the summit of a cerebral convolution, and is consequently closely applied to the subjacent pia mater, the meshwork is so close and the trabeculæ so short that the two membranes cannot be separated from each other. To the dissector they appear to form a single lamina. In the intervals between the

rounded margins of adjacent convolutions, distinct angular spaces exist between the arachnoidea and the pia mater. In these the subarachnoid tissue can be studied, and it will be seen that by these intervals on the surface of the cerebrum, numerous communicating channels are formed which serve for the free passage of the subarachnoid fluid from one part of the brain to another. The larger branches of the arteries and veins of the brain traverse the subarachnoid space; their walls are directly connected with the subarachnoid trabeculæ, and are bathed by the subarachnoid fluid.

Cisternæ Subarachnoidales.—In certain situations the arachnoidea is separated from the pia mater by intervals of considerable depth and extent. These expansions of the subarachnoid space are termed cisternæ subarachnoidales. In these the subarachnoid tissue is reduced to a minimum. There is no longer a close meshwork; the trabeculæ connecting the two bounding membranes take the form of long filamentous intersecting threads, which traverse the spaces. A beautiful demonstration of these may be obtained by dividing in the mesial plane, with the scissors, the sheet of arachnoidea which is spread over the medulla and pons, and turning the two pieces gently outwards.

Certain of the cisternæ require special mention. The largest and most conspicuous is called the *cisterna magna*. It is a direct continuation of the posterior part of the subarachnoid space of the spinal cord upwards into the hinder part of the cranium. It is formed by the arachnoid membrane bridging over the wide interval between the back part of the under surface of the cerebellum and the medulla oblongata.

The *cisterna pontis* is the name given to another of these recesses. It is the continuation upwards on the floor of the cranium of the anterior part of the subarachnoid space of the cord. In the region of the medulla it is continuous on either side with the cisterna magna, so that this subdivision of the brain is completely surrounded by a wide subarachnoid space.

In front of the pons Varolii the arachnoid membrane bridges across between the projecting temporal lobes, and covers in the deep hollow in in this region of the base of the brain. This space is called the *cisterna*

basalis, and within it are placed the large arteries which take part in the formation of the circle of Willis. Leading out from the cisterna basalis there are certain wide subarachnoid channels. Two of these are prolonged into the Sylvian fissures, and in these are accommodated the middle cerebral arteries and some of their branches. In front the basal cistern passes into a space in front of the optic chiasma, and from this it is continued into the great longitudinal fissure above the corpus callosum. In this subarachnoid passage are lodged the anterior cerebral arteries.

All the subarachnoid cisterns communicate in the freest manner with each other, and also with the narrow intervals on the surface of the cerebrum. The subarachnoid space does not communicate in any way with the subdural space. In certain localities, however, it communicates with the ventricular system of the brain. Three such apertures are described in connection with the fourth ventricle, whilst another slit is said to lead from the cisterna basalis into the lower end of the descending horn of the lateral ventricle.

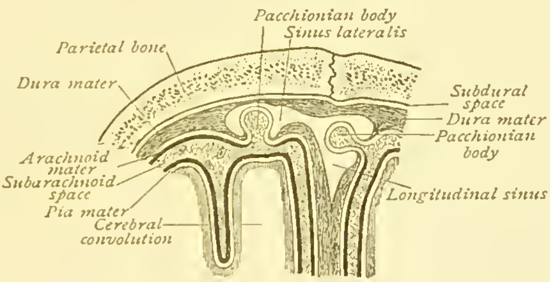


FIG. 277.—Diagram of the membranes of the brain and of the Pacchionian bodies.

Pacchionian Bodies.—The connection of the Pacchionian bodies with the arachnoid mater has already been referred to (p. 115).

Pia Mater.—The pia mater forms the immediate investment of the brain. It is finer and more delicate than the corresponding membrane of the spinal cord, and it follows closely all the inequalities on the surface of the brain. Thus, in the case of the cerebrum, it dips down so as to line both sides of every sulcus and form a fold within it. On the cerebellum the relation is not so intimate; it is only

the larger fissures of the cerebellum which contain folds of pia mater.

The larger blood vessels of the brain, as we have noted, run in the subarachnoid space. The finer twigs enter the pia mater and ramify in it before proceeding into the substance of the brain. As they enter they carry with them sheaths derived from the pia mater. Consequently, if the dissector raises a portion of this membrane from the surface of the cerebrum, a number of fine processes will be seen to be withdrawn from the cerebral substance. These are the blood vessels, and they give the deep surface of the membrane a rough and flocculent appearance.

The pia mater is not confined to the exterior of the brain. A fold is carried into its interior. This will be exposed in the dissection of the brain, and described under the name of the velum interpositum or the tela choroidea superior.

Dissection.—The blood vessels of the brain should now be followed out as far as it is possible to do so without laceration of the brain substance. Begin by stripping the arachnoidea from the base of the brain. This will bring into view the main trunks. In describing the vessels of the brain it is unfortunately necessary to speak of many parts which have not yet come under the notice of the dissector.

Arteries which supply Blood to the Brain.—Four main arterial trunks carry blood into the cranium for the supply of the brain—viz., the two internal carotid arteries and the two vertebral arteries. The vertebral arteries enter through the foramen magnum, whilst the internal carotid arteries gain admittance through the carotid canals. These vessels have been divided in the removal of the brain. The cut end of the internal carotid will be seen on the base of the brain immediately to the outer side of the optic nerve; the vertebral lies on the side of the medulla oblongata. A very remarkable and complete anastomosis takes place on the base of the brain by the inosculation of branches which spring from the carotid and vertebral arterial systems. This is termed the circle of Willis. The branches which take

part in this anastomosis are placed in that large expansion of the subarachnoid space which we have termed the cisterna basalis.

Two systems of branches, both going to the cerebrum, but differing greatly in their mode of distribution, proceed from the vessels forming the circle of Willis. One system consists of very numerous slender twigs, which, as a rule, come off in groups in certain localities, and at once pierce the substance of the cerebrum so as to gain its interior. These are the *central* or *basal branches*. The other system is composed of branches which ramify over the surface of the cerebrum, and are termed the *cortical branches*. The central parts of the brain, including the basal ganglia, receive their blood supply from the basal system, and the vessels which constitute this group do not anastomose with each other. The cortical vessels supply the cerebral cortex, and the finer branches which ramify in the pia mater anastomose with each other. It so happens, therefore, that neighbouring vascular districts of the cerebral cortex are not sharply cut off from each other.

Vertebral Artery.—The vertebral artery enters the subarachnoid space in the upper part of the vertebral canal by piercing the dura mater and the arachnoid mater. Gaining the interior of the cranium through the foramen magnum, it is continued upwards on the side of the medulla oblongata. Soon it inclines forwards towards the front of the medulla, and, meeting its fellow of the opposite side in the mesial plane, it unites with it at the lower border of the pons Varolii to form the basilar artery.

During this part of its course the vertebral artery gives off the following branches :—

1. Posterior meningeal.
2. Posterior spinal.
3. Posterior inferior cerebellar.
4. Anterior spinal.
5. Bulbar.

The *posterior meningeal branch* (ramus meningeus) springs from the vertebral artery before it pierces the dura mater, and is distributed in the posterior cranial fossa (p. 134).

The *posterior spinal* (arteria spinalis posterior) is the first branch that is given off after the vertebral artery pierces the dura mater. It passes downwards on the spinal cord in relation to the posterior nerve-roots (p. 179).

The *posterior inferior cerebellar* (arteria cerebelli inferior posterior) is the largest branch of the vertebral artery, and it takes origin immediately above the posterior spinal artery. It pursues a tortuous course backwards on the side of the upper part of the medulla, between the nerve-roots of the hypoglossal, and then between the roots of the vagus. Finally, turning round the restiform body, it gains the vallecula of the cerebellum, where it ends by dividing into two terminal branches. Of these, one turns backwards in the sulcus, between the inferior vermiform process and the lateral hemisphere of the cerebellum, whilst the other ramifies on the posterior part of the inferior surface of the cerebellum.

The *anterior spinal artery* (arteria spinalis anterior) arises near the lower border of the pons Varolii. It is rare to find the vessels of the two sides of equal size. They converge on the anterior surface of the medulla, and unite to form the commencement of the median vessel which extends downwards on the ventral face of the cord.

The *bulbar arteries* are minute vessels which enter the substance of the medulla, and spring both from the vertebral artery itself and also from its branches.

The Basilar Artery (arteria basilaris), which is formed by the union of the two vertebral arteries, is a short trunk which extends in the mesial plane from the lower to the upper border of the pons Varolii. At the latter point it ends by dividing into the two posterior cerebral arteries. The basilar artery lies in the middle part of the cisterna pontis, and occupies the median groove on the ventral or anterior surface of the pons Varolii. In front, it is supported by the basilar process of the occipital bone and the dorsum sellæ of the sphenoid.

The branches which spring from the basilar artery, for the

most part, proceed outwards from either side of the vessel. They are :—

1. Transverse.
2. Internal auditory.
3. Anterior inferior cerebellar.
4. Superior cerebellar.
5. Posterior cerebral.

The *transverse arteries* (rami ad pontem) are numerous slender twigs which run outwards on the surface of the pons and enter its substance. The *auditory artery* (arteria auditiva interna) will be seen amongst these. It follows the auditory nerve into the internal auditory meatus, and is distributed to the internal ear.

The *anterior inferior cerebellar* (arteria cerebelli inferior anterior) inclines outwards and backwards to reach the anterior part of the inferior surface of the cerebellum.

The *superior cerebellar artery* (arteria cerebelli superior) is a large vessel which springs from the basilar close to its termination. It winds outwards and backwards along the upper border of the pons Varolii to reach the upper surface of the cerebellum, upon which it spreads out in a number of large branches which, for the most part, take a backward course.

The Posterior Cerebral Artery (arteria cerebri posterior). —Immediately beyond the origin of the two superior cerebellar arteries, the basilar trunk bifurcates into the two posterior cerebral arteries. These diverge from each other, and, curving outwards, they encircle the mesencephalon, and are carried backwards towards the under surface of the splenium of the corpus callosum. In this course the posterior cerebral artery lies deeply in the interval between the corresponding crus cerebri and the hippocampal gyrus, and, finally passing on to the tentorial surface of the cerebral hemisphere, it disappears from view by sinking into the anterior extremity of the calcarine fissure. In this fissure the artery ends by dividing into two terminal branches, viz., the calcarine and the parieto-occipital (Figs. 278 and 279).

The third or oculomotor nerve passes forwards in the

interval between the posterior cerebral and the superior cerebellar arteries, close to the place where they arise from the basilar; and the small fourth or trochlear nerve is related to the posterior cerebral artery as it winds round the crus cerebri.

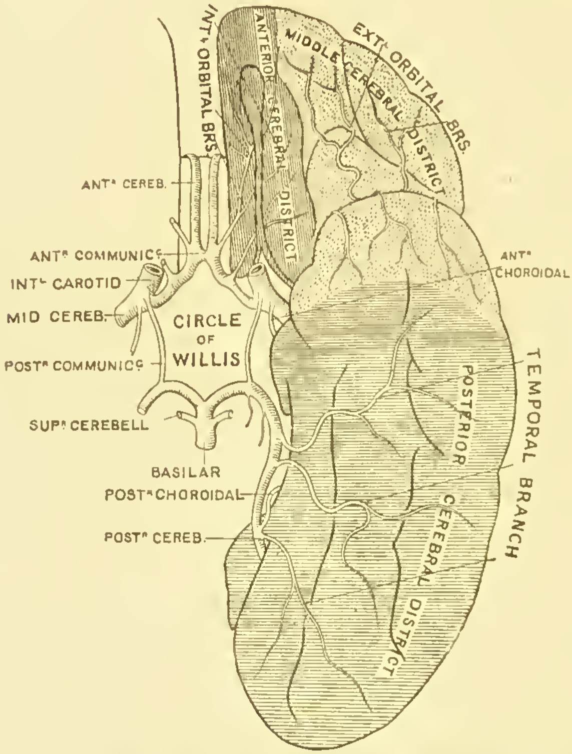


FIG. 278.—The circle of Willis and the distribution of the arteries on the under surface of the cerebrum.

The following branches spring from the posterior cerebral artery :—

Central or basal	Postero-mesial. Postero-lateral. Posterior choroidal.	Cortical	Temporal. Calcarine. Parieto-occipital.

The *postero-mesial central arteries* arise close to the origin of the parent trunk. They proceed upwards in the interval between the crura cerebri, and piercing the locus perforatus posticus, they supply the optic thalamus and the inner part of the crus cerebri.

The *postero-lateral central arteries* are a group of small slender twigs

which arise on the outer surface of the crus cerebri, and go to the corpora quadrigemina and the optic thalamus.

The *posterior choroidal artery*, somewhat larger, goes to the velum interpositum and the choroid plexus of the lateral ventricle (Figs. 278 and 279).

The *temporal branches*, two or three in number, turn outwards over the hippocampal gyrus, and ramify on the under surface of the temporal lobe of the cerebrum (Fig. 278).

The *calcarine branch* (arteria occipitalis) follows the calcarine fissure to the occipital pole of the cerebral hemisphere, round which it turns to reach the outer surface of the occipital lobe. It is the chief artery of supply to the cuneus and the lingual convolution, and is therefore specially concerned in the nutrition of the visual centres in the cerebral cortex (Fig. 279).

The *parieto-occipital artery* is the smaller of the two terminal branches of the posterior cerebral. It runs upwards in the parieto-occipital fissure, and reaching the upper margin of the cerebrum, it turns round this to reach the outer surface of the occipital lobe. It supplies branches to the cuneus and præcuneus (Fig. 279).

Internal Carotid Artery.—The terminal part of this great vessel lies on the outer side of the optic chiasma, in the angle between the optic nerve and the optic tract. At the anterior perforated spot, close to the commencement of the Sylvian fissure, it ends by dividing into the anterior and middle cerebral arteries (Fig. 278). The *middle cerebral artery* is the larger of the two terminal branches, and, as it enters the Sylvian fissure, it appears to be the continuation of the parent-trunk. The *anterior cerebral artery*, on the other hand, proceeds inwards from the internal carotid at almost a right angle. This explains how it is that emboli pass more frequently into the middle cerebral than into the anterior cerebral artery. From the internal carotid artery, after it has emerged from the cavernous sinus (p. 358), the following branches arise :—

1. Ophthalmic (already studied, p. 370).
2. Posterior communicating.
3. Anterior choroidal.
4. Middle cerebral.
5. Anterior cerebral.

The *posterior communicating artery* (arteria communicans posterior) is as a rule a slender branch which proceeds

backwards to join the posterior cerebral between its postero-mesial and postero-lateral groups of basal twigs.

The *anterior choroidal artery* (arteria choroidea) enters the descending cornu of the lateral ventricle, and passes into the choroid plexus in that cavity (Fig. 278).

The *anterior cerebral artery* (arteria cerebri anterior) in the first instance takes a horizontal course inwards and forwards (Fig. 278). It passes above the optic nerve and in front of the optic chiasma, and finally reaches the hinder end of that part of the great longitudinal fissure which separates the frontal lobes of the cerebrum. Here it lies close to its

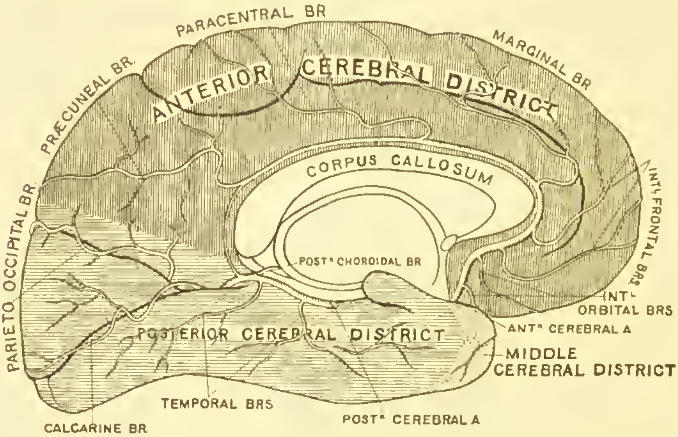


FIG. 279.—The vessels supplying the cortex on the inner surface of the cerebrum.

fellow of the opposite side, and the two vessels are connected by a short transverse trunk of communication, termed the *anterior communicating artery* (arteria communicans anterior). The anterior cerebral artery now enters the great longitudinal fissure, and is carried forwards and upwards on the inner surface of the frontal lobe towards the genu or anterior extremity of the corpus callosum (Fig. 279). Round this it turns, and it is then continued backwards on the upper surface of the corpus callosum. Very much reduced in size, it gives off its terminal branch (termed the artery of the

corpus callosum), which may be traced as far as the splenium or posterior end of the corpus callosum.

Numerous branches proceed from the anterior cerebral artery :—

Basal or central { Antero-mesial.

Cortical {
Inferior internal frontal (or internal orbital).
Anterior internal frontal.
Middle internal frontal (or paracentral).
Posterior internal frontal (or præcuneal).

The *antero-mesial group* of arteries pierce the inner part of the locus perforatus anticus, and supply the enlarged anterior end of the caudate nucleus.

The *inferior internal frontal branches* (internal orbital) are two or three in number, and turn round the inner margin of the great longitudinal

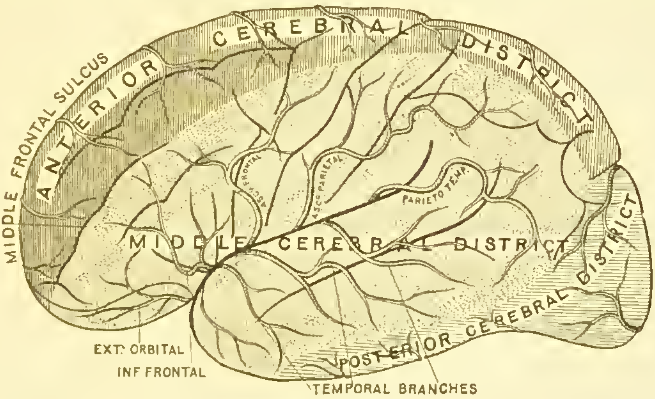


FIG. 280.—The arteries distributed on the outer surface of the cerebral hemisphere.

fissure to reach the inner part of the orbital surface of the frontal lobe. They supply the gyrus rectus, the olfactory peduncle and bulb, and the internal orbital convolution (Figs. 278 and 279).

The *anterior internal frontal artery* ramifies upon the fore-part of the inner surface of the frontal lobe, and its terminal twigs turn round the upper margin of the cerebral hemisphere, and supply the outer surface of the frontal lobe as far down as the sulcus frontalis medius (Fig. 279).

The *middle internal frontal artery* (paracentral) ramifies on the inner surface of the frontal lobe behind the preceding branch. Its terminal part passes over the paracentral convolution, and reaches the adjacent portion of the outer surface of the cerebral hemisphere (Fig. 279).

The *posterior internal frontal artery* (præcuneal) ramifies on the inner surface of the præcuneus, and its terminal twigs turn round the upper margin of the cerebral hemisphere to gain its outer surface.

The Middle Cerebral Artery (arteria cerebri media) passes outwards and upwards in the Sylvian fissure, and soon breaks up into a number of large terminal branches, which spread out on the surface of the island of Reil. Before the posterior limb of the Sylvian fissure is opened up so as to expose the island of Reil, these branches are observed streaming out from between its two lips (Fig. 280). They then diverge so as to supply a wide area of cortex on the outer surface of the cerebral hemisphere.

The branches which spring from the middle cerebral artery may be classified thus :—

- Central or basal branches.
  - Antero-lateral.
- Cortical branches
  - Frontal
    - External orbital.
    - External inferior frontal.
    - Ascending frontal.
  - Parietal.
    - Ascending parietal.
  - Parieto-temporal.
  - Temporal.

The antero-lateral group of basal arteries are very numerous. They pierce the outer part of the anterior perforated spot and supply the lenticular nucleus, the internal and the external capsule, the caudate nucleus and a portion of the optic thalamus.

The *frontal* and *parietal branches* turn round the upper lip of the posterior limb of the Sylvian fissure and ascend on the outer surface of cerebrum. The *frontal branches* are : (1) an *external orbital* to the outer part of the orbital surface of the frontal lobe ; (2) an *inferior external frontal* to the inferior frontal convolution ; (3) an *ascending frontal* which runs upwards in relation to the ascending frontal convolution.

The *ascending parietal branch* extends in an upward and backward direction in relation to the ascending parietal convolution, and its terminal twigs supply the greater part of the cortex of the superior parietal convolution.

The *parieto-temporal branch* is a very large artery which issues from

the hinder part of the posterior limb of the fissure of Sylvius and sends branches upwards to the inferior parietal convolution and others which incline downwards over the hinder part of the temporal lobe. Its twigs, as a rule, do not encroach upon the outer surface of the occipital lobe.

The *temporal branches*, two or three in number, issue from the posterior limb of the Sylvian fissure, and turning downwards and backwards over its lower lip (*i.e.*, the first temporal convolution), they ramify upon the outer surface of the temporal lobe.

Circle of Willis (circulus arteriosus Willisii). This remarkable anastomosis is placed on the base of the brain in the deep hollow in front of the pons Varolii. It takes the form of a heptagonal or hexagonal ring, and the vessels which compose it lie in the large basal subarachnoid space. In front it is closed by the anterior communicating artery which links together the two anterior cerebral arteries. On either side is the posterior communicating artery connecting the internal carotid (from which the anterior cerebral springs) with the posterior cerebral. Behind, the arterial ring is completed by the bifurcation of the basilar artery into the two posterior cerebral vessels (Fig. 278). As a rule the circle of Willis is not symmetrical. The right posterior communicating artery is almost invariably larger than its fellow of the opposite side.

Dissection.—The brain being placed with its base uppermost, the dissector should proceed to remove the blood vessels and membranes from its surface. This must be done with the forceps and a pair of scissors. It is a dissection which requires very delicate manipulation, because the cranial nerves at their points of attachment to the brain are so intimately connected with the pia mater that any undue traction applied to the membranes will tear the nerves away altogether. Indeed, in the case of the medulla oblongata, the dissector is advised to leave the pia mater in position until the nerve roots have been studied. The relation of the pia mater to the fourth ventricle likewise renders this desirable. In so far as the other nerves are concerned, the pia mater may be divided carefully around their roots with the scissors.

In removing the arachnoidea and pia mater from the outer surface of the cerebrum, it is well to raise it in the first instance from the margins of the hemisphere, and then work towards the fissure of Sylvius. By so doing, the membranes and vessels within this great fissure and in relation to the island of Reil can be withdrawn without damage to the brain

substance. Of course, at the present stage, the membranes cannot be removed from every part of the brain, but as the dissection proceeds, opportunities for completing the process will arise.

BASE OF BRAIN.

Interpeduncular Space.—When the membranes are removed from the base of the brain, the *crura cerebri*, two

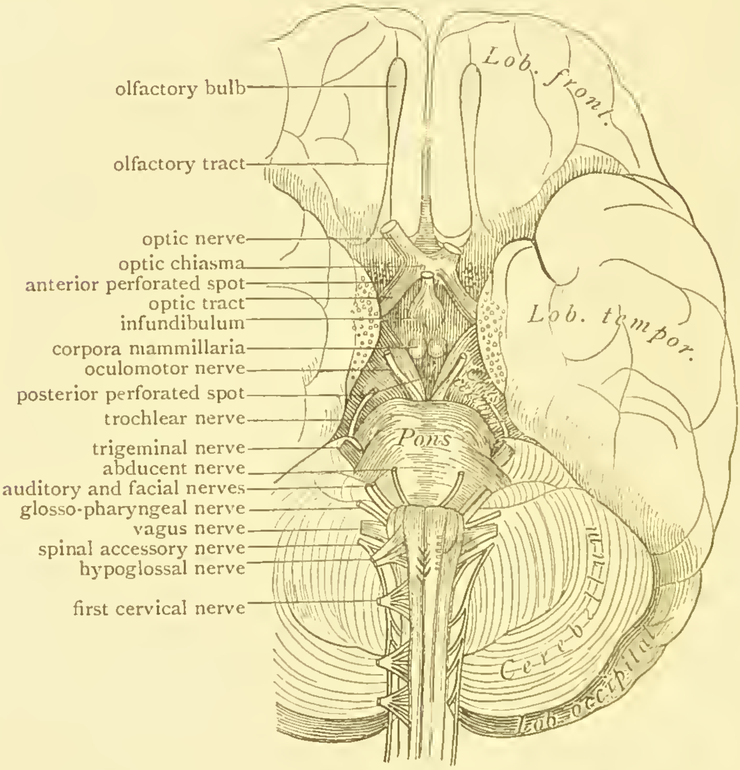


FIG. 281.—Base of the brain, showing the interpeduncular space. (GEGENBAUR.)

large rope-like strands, will be seen issuing from the upper aspect of the pons Varolii. Placed close together as they emerge from the pons, they diverge as they proceed upwards and forwards, and finally each crus disappears into the

corresponding side of the cerebrum. Turning round the outer aspect of each crus where it passes into the cerebrum will be seen a flattened band, called the *optic tract.* These bands converge as they pass forwards, and are finally joined together by a short transverse commissural portion, termed the *optic chiasma.* This chiasma is placed below the hinder end of that portion of the great longitudinal fissure which intervenes between the frontal lobes of the cerebrum, and when the brain is in position it rests upon the olivary eminence of the sphenoid bone. The *optic nerve* is continued forwards and outwards from the chiasma and the tract.

The crura cerebri, the optic tracts, and the optic chiasma enclose a rhomboidal or lozenge-shaped interval on the base of the brain, which is termed the *interpeduncular space.* Within the limits of this area the following parts may be seen as we pass from behind forwards:—(1) the locus perforatus posticus; (2) the corpora mammillaria; (3) the tuber cinereum, attached to which is the infundibulum of the pituitary body. These structures form the floor of the third ventricle of the brain.

The *oculomotor nerves* issue from the brain within the interpeduncular space. Each nerve emerges from the inner side of the corresponding crus cerebri.

Locus Perforatus Posticus.—At its posterior angle, immediately in front of the pons Varolii, the interpeduncular space is very deep, and is floored by a layer of grey matter which is perforated by numerous small apertures. This is the *locus perforatus posticus.* From the apertures which are dotted over its surface the postero-mesial basal branches of the posterior cerebral artery have been withdrawn.

The Corpora Mammillaria are two small white pea-like eminences placed side by side in front of the locus perforatus posticus. At a later stage of the dissection their connection with the anterior pillars of the fornix will be brought out.

The Tuber Cinereum is a slightly raised field of grey matter which occupies the interval between the anterior portions of

the optic tracts in front of the corpora mammillaria. Springing from the fore part of the tuber cinereum, immediately behind the optic chiasma, is the infundibulum or stalk of the pituitary body. In the removal of the brain its connection with that body has been severed.

The Locus Perforatus Anticus is a small triangular district of grey matter, which is bounded behind by the uncinate extremity of the hippocampal gyrus; in front by the diverging roots of the olfactory peduncle; and internally by the optic tract. It leads in an outward direction into the Sylvian fissure, and is perforated by the antero-mesial and the antero-lateral groups of basal arteries. The grey matter in this area is continuous above with the grey matter of the lenticular nucleus.

Lamina Cinerea.—If the optic chiasma be now gently raised with the forceps, a thin lamina will be noticed passing upwards from it into the great longitudinal fissure, to become connected with the rostrum of the corpus callosum. This is the *lamina cinerea*. It closes the third ventricle in front, and is continuous on either side with the grey matter of the locus perforatus anticus.

Superficial Origins of the Cranial Nerves. — Twelve cranial nerves are enumerated as arising from the brain on either side of the mesial plane. These are the olfactory, or first; the optic, or second; the oculomotor, or third; the trochlear, or fourth; the trigeminal, or fifth; the abducent, or sixth; the facial, or seventh; the auditory, or eighth; the glosso-pharyngeal, or ninth; the vagus, or tenth; the spinal accessory, or eleventh; and the hypoglossal, or twelfth.

Each of these nerves is said to have a "superficial" and a "deep" origin. By the term "superficial origin," we refer to the point where its fibres enter or leave the brain surface; by the term "deep origin," we indicate the connections which are established by the fibres of the different nerves within the substance of the brain. It is the former only which comes under our notice at the present time.

No fewer than eight of the cranial nerves will be noticed to spring from the medulla oblongata and the pons Varolii.

Hypoglossal Nerve.—Upon the lateral aspect of the medulla, in its upper half, a very conspicuous oval prominence called the olivary eminence may be distinguished. A distinct sulcus or groove, which passes downwards in front of this body, separates it from an elongated strand, termed the anterior pyramid of the medulla. From the bottom of this sulcus a continuous series of nerve fascicles will be seen to issue along the whole length of the medulla. These nerve fascicles belong to two different nerves. Those which issue from the lower part of the groove, below the level of the olivary eminence, belong to the *anterior root* of the *first cervical nerve*; those which emerge from the upper part of the groove, in the interval between the olivary body and the pyramid, form the *hypoglossal nerve.*

Glosso-pharyngeal, Vagus and Spinal Accessory Nerves.—Behind the olivary eminence, between it and a prominence called the restiform body, there is another continuous row of nerve fascicles connected with the medulla. These extend downwards beyond the level of the olivary eminence, and are attached to the whole length of the medulla in linear order. They belong to three nerves, but it is impossible at present (seeing that the nerve-trunks that they build up are divided) to determine precisely the number of roots which belong to each. From below upwards the nerves which they form are the *spinal accessory*, the *vagus*, and the *glosso-pharyngeal.* The vagus and the glosso-pharyngeal, which issue from the interval between the olivary eminence and the restiform body, have their fascicles of origin much more closely crowded together than the spinal accessory.

The medullary roots of the spinal accessory constitute only one part of the nerve. The *spinal part* springs from the spinal cord, as low down as the sixth cervical nerve, by a series of roots which issue from the lateral

column behind the attachment of the ligamentum denticulatum.

The Auditory and Facial Nerves issue close together at the lower border of the pons Varolii, and immediately above the restiform body. The *auditory nerve* is the larger of the two, and lies to the outer side of the facial. Its two roots embrace the restiform body.

The *facial nerve* issues from the pons close to its lower border, and immediately to the inner side of the auditory nerve. Between these two nerves a slender filament will be observed. This is the *pars intermedia* of Wrisberg. It joins the facial in the internal auditory meatus.

The Abducent is a small nerve, which emerges from the front of the medulla in the groove between the lower border of the pons Varolii and the outer part of the anterior pyramid.

The Trigeminal or Fifth is the largest of all the cranial nerves. It appears on the side of the pons Varolii, nearer its upper than its lower border, and in a line with the facial and auditory nerves. It consists of two roots—a large sensory root composed of a great number of fasciculi loosely held together, and a very small, more compact motor root which emerges in front and slightly to the inner side of the point at which the sensory root enters the pons.

Trochlear Nerve.—The superficial origin of the trochlear or fourth nerve cannot be seen at present. It emerges from the valve of Vieussens. It is a delicate little nerve which has a long intracranial course, and may be observed winding round the outer side of the crus cerebri, between the cerebrum and cerebellum.

The Oculomotor Nerve may be seen within the interpeduncular space. It issues by several fascicles from the sulcus oculomotorius on the inner face of the crus cerebri.

The Optic is a large round nerve which proceeds outwards and forwards from the optic tract and optic chiasma. The origin of the optic tract will be studied at a later stage.

The Olfactory Nerves arise from the olfactory bulb or lobe, and enter the nasal chamber through the foramina in the cribriform plate of the ethmoid bone.

General Connections of the Several Parts of the Brain.—Before proceeding to the more particular study of the different parts of the brain, it is well that the student should acquire a general conception of the manner in which these are connected with each other. In the posterior cranial

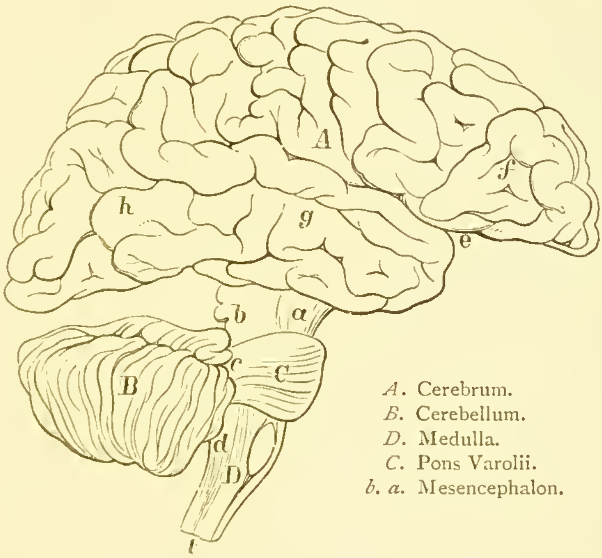


FIG. 282.—Diagrammatic view of the manner in which the several parts of the brain are connected with each other. (From SCHWALBE).

fossa, below the tentorium, are placed the medulla oblongata, the pons Varolii, and the cerebellum. These structures surround a cavity which is called the fourth ventricle of the brain, and all stand in intimate connection with each other. The medulla oblongata is for the most part carried upwards into the pons Varolii, but at the same time two large strands on its posterior or dorsal aspect, termed the restiform bodies, are prolonged into the cerebellum, and constitute

its *inferior peduncles*, or the bonds of union between the medulla and the cerebellum (Fig. 282, *d*). The transverse fibres of the pons Varolii are gathered together on either side in the form of a large rope-like strand. This disappears into the corresponding hemisphere of the cerebellum and constitutes its *middle peduncle* (Fig. 282, *c*).

The great mass of the brain is termed the cerebrum. This occupies the anterior and middle cranial fossæ, and extends backwards into the occipital region above the tentorium and the cerebellum. The greater part of the cerebrum is formed by the cerebral hemispheres, which are separated from each other in the mesial plane by the great longitudinal fissure. At the bottom of this fissure may be seen the *corpus callosum*, a broad commissural band which connects the two cerebral hemispheres with each other. Each hemisphere is hollow—the cavity in its interior being termed the *lateral ventricle* of the brain. Between and below the cerebral hemispheres, and almost completely concealed by them, is the *inter-brain* or the *thalamencephalon*. The principal parts forming this portion of the brain are the two optic thalami, between which is the *third ventricle* of the brain—a deep, narrow cavity occupying the mesial plane. The third ventricle communicates with the lateral ventricles through two small apertures, termed the *foramina of Monro*.

The cerebrum is connected with the parts in the posterior cranial cavity (pons Varolii, cerebellum, and medulla oblongata) by a narrow stalk called the *isthmus encephali*, the *mid-brain*, or the *mesencephalon*. The mid-brain is built up of the crura cerebri, passing from the pons Varolii to the cerebrum (Fig. 282, *a*), the corpora quadrigemina forming its dorsal part (Fig. 282, *b*), the superior cerebellar peduncles proceeding from the cerebellum to the cerebrum, &c. It is tunnelled by a narrow passage—the *aqueduct of Sylvius*—which extends between the fourth and the third ventricles.

THE CEREBRUM.

The Cerebral Hemispheres.—Each cerebral hemisphere presents an external, an internal, and an inferior surface, separated from each other by more or less distinctly marked borders. The *external surface* is convex, and is adapted to the concavity of the cranial vault. The *internal surface* is flat and perpendicular, and is more or less completely separated from the corresponding surface of the opposite side by the falx cerebri, which occupies the great longitudinal fissure. The *inferior surface* is irregular, and is adapted to the anterior and middle cranial fossæ, and also to the upper surface of the tentorium cerebelli. Traversing this surface in a transverse direction, nearer the anterior end of the hemisphere than the posterior end, is the stem of the Sylvian fissure (Fig. 282, *e*). This deep cleft divides the inferior surface into a front or *orbital area*, which rests upon the orbital plate of the frontal bone, and is consequently concave from side to side, and a more extensive posterior area which lies on the floor of the lateral part of the middle cranial fossa and the upper surface of the tentorium cerebelli. This portion of the inferior surface is frequently termed the *tentorial surface.*

The borders which separate these surfaces from each other are the supero-mesial, the superciliary, the infero-lateral, and the internal occipital. The *supero-mesial border*, convex from before backwards, intervenes between the internal and external surfaces. The *superciliary border* is highly arched, and separates the orbital surface from the external surface. The *infero-lateral border* marks off the tentorial surface from the external surface. The *internal orbital border* is not very distinct, except in cases were the brain has been hardened *in situ.* It extends from the posterior extremity of the hemisphere to the hinder end of the corpus callosum, and intervenes between the mesial and tentorial surfaces.

The most projecting part of the anterior end of the cerebral hemisphere is usually called the *frontal pole*, whilst the most projecting part of the hinder end is termed the *occipital pole*. Again, on the under surface of the hemisphere, the prominent point of cerebral substance, which extends forwards below the Sylvian fissure, receives the name of the *temporal pole*. In a well hardened brain a broad groove is usually present on the inner aspect of the occipital pole of the right hemisphere. This corresponds to the commencement of the right lateral venous sinus.

Great Longitudinal Fissure (incisura pallii). This great mesial cleft is occupied by the fold of dura mater termed the falx cerebri. In front and behind it completely separates the cerebral hemispheres from each other, but in its middle part it is floored by the corpus callosum—the commissural band which passes between the hemispheres and connects them together. The upper surface of the corpus callosum can be displayed by gently drawing asunder the two sides of the incisura longitudinalis.

Dissection.—If two brains are available the dissector is advised at this stage to separate in one of these the cerebrum from the cerebellum, pons and medulla, by cutting transversely through the mid-brain or isthmus encephali. The cerebrum may then be split in the mesial plane by placing a long knife in the longitudinal fissure, and dividing with one sweep the various parts which connect the two sides to each other. By this proceeding, the three surfaces of each cerebral hemisphere are exposed, and the gyri and sulci can be fully and satisfactorily studied. If only one brain is at the disposal of the student he should not make this dissection, but endeavour to follow out the gyri and sulci with the various parts of the brain in position. No doubt he studies the hemispheres in this way at a disadvantage, but as the dissection goes on opportunities will occur which will enable him to examine those districts of the surface which he can only see very imperfectly at present.

Cerebral Gyri and Sulci.—The surface of the cerebral hemispheres is rendered highly irregular by the presence of convolutions or gyri, separated from each other by intervening furrows, termed sulci or fissures. The surface pattern, which is presented by these gyri and sulci, is in its general

features the same in all human brains; but when the comparison is pushed into the more minute details of the arrangement many differences become manifest, not only in the brains of different individuals, but also in the two cerebral hemispheres of one individual.

Of the furrows we have to recognise two varieties, viz., complete and incomplete. The *complete fissures* are few in number, and they consist of inwardly directed folds which involve the whole thickness of the cerebral wall. They consequently show in the interior of the cerebral cavity or lateral ventricle in the form of internal elevations on its wall. In this category we include (1) the dentate or hippocampal fissure; (2) the anterior portion of the calcarine fissure; and (3) a portion of the collateral fissure. The *incomplete sulci* are merely surface furrows of very varying depth which do not produce any effect on the inner surface of the ventricular wall.

General Structure of the Cerebral Hemispheres.—Each cerebral hemisphere is composed of an outside coating of grey matter spread in a continuous and uninterrupted layer over its entire surface, except where the corpus callosum enters, and an internal core of white matter. The grey coating is termed the *cerebral cortex*, whilst the white internal part is called the *medullary centre*. But in addition to the grey matter on the outside, there are certain large deposits of grey matter embedded in the substance of each hemisphere in its basal part. These constitute the *cerebral nuclei*, and although to a certain extent isolated from the grey matter on the surface, it will be observed later on that at certain points they are directly continuous with it.

Each convolution shows a corresponding structure. It has an external covering of grey matter supported upon a core of white medullary matter.

By means of the convolutions and sulci the grey matter on the surface of the hemisphere is enormously increased,

without unduly adding to the bulk of the organ, and the vascular pia mater, which dips into every fissure, is increased in extent to a like degree. Opportunity is therefore afforded to the cortical vessels of breaking up into twigs of exceeding fineness before entering the substance of the

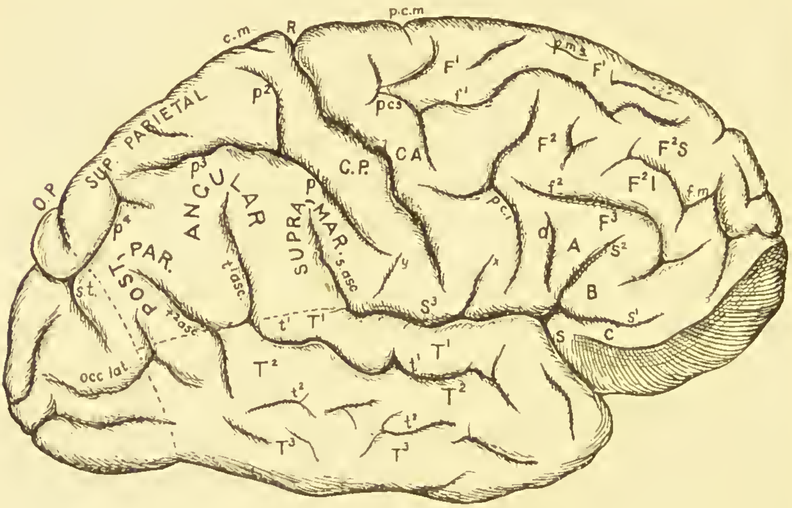


FIG. 283.—Outer surface of the right cerebral hemisphere of a female brain, in which the arrangement of the gyri and sulci is very simple.

S. Stem of the fissure of Sylvius.
S1. Anterior horizontal limb of Sylvian fissure.
S2. Ascending limb of Sylvian fissure.
S3. Posterior horizontal limb of Sylvian fissure.
R. Fissure of Rolando.
O.P. Parieto-occipital fissure.
C.A. Ascending frontal convolution.
C.P. Ascending parietal convolution.
p.c.i. Inferior præcentral sulcus.
p.c.s. Superior præcentral sulcus.
p.c.m. Medial præcentral sulcus.
f1 & *f2*. Superior and inferior frontal sulci.
f.m. Middle frontal sulcus.
p.m.s. Paramedial sulcus.
F1, F2, & F3. Superior middle and inferior frontal gyri.
F2S. Upper part of middle frontal gyrus.
F2I. Inferior part of middle frontal gyrus.
d. Sulcus diagonalis.
A. Pars basilaris of inferior frontal gyrus.
B. Pars triangularis of inferior frontal gyrus.
C. Pars orbitalis of inferior frontal gyrus.
c.m. Calloso-marginal fissure.
p1, *p2*, *p3*, *p4*. Four parts of the intra-parietal sulcus.
s.t. Sulcus occipitalis transversus.
occ. lat. Sulcus occipitalis lateralis.
t1 and *t2*. Superior and inferior temporal sulci.
T1, T2, T3. The three temporal gyri.
s. asc., *t1 asc.*, *t2 asc.* The upturned ends of the posterior limb of Sylvian fissure and the two temporal sulci.

hemisphere. The distribution of the blood to the grey cortex is in this way equalised.

Cerebral Lobes and Interlobar Fissures.—Certain of the fissures which traverse the surface of the cerebrum are arbitrarily chosen for the purpose of subdividing the surface into districts, termed lobes. These fissures, which receive the name of *interlobar*, are the following—(1) the fissure of Sylvius; (2) the fissure of Rolando; (3) the parieto-occipital; (4) the calloso-marginal; (5) the collateral; and (6) the limiting sulcus of Reil.

The lobes which are mapped out by these fissures are—(1) the frontal; (2) the parietal; (3) the occipital; (4) the temporal; (5) the central or island of Reil; (6) the falciform or limbic. To these may be added a seventh lobe, in no way related to the interlobar fissures, viz., the olfactory lobe.

The Fissure of Sylvius is the most conspicuous fissure on the surface of the cerebrum. It is composed of a short main stem from the outer extremity, of which three branches radiate. The *stem* of the Sylvian fissure is placed on the inferior surface of the cerebrum (Fig. 283, S). It begins at the locus perforatus anticus in a deep depression called the *vallecula Sylvii.* From this it passes horizontally outwards, forming a deep cleft between the temporal pole and the orbital surface of the frontal lobe. Appearing on the outer surface of the cerebrum, the Sylvian fissure immediately divides into three radiating branches. These are—(1) the ramus horizontalis posterior; (2) the ramus horizontalis anterior; and (3) the ramus ascendens anterior.

The *posterior horizontal limb* (Fig. 283, S^3) is the longest and the most conspicuous of the three. It extends backwards with a slight inclination upwards for a distance of two inches or more between the frontal and parietal lobes which lie above it, and the temporal lobe which is placed below it. Finally, it comes to an end by turning upwards into the parietal lobe in the form of an *ascending terminal piece* (Fig. 283 *s. asc.*)

The *anterior horizontal limb* (Fig. 283, S^1) extends horizontally forwards in the frontal lobe for a distance of about three-quarters of an inch immediately above and parallel to the posterior part of the superciliary margin of the hemisphere.

The *ascending limb* (Fig. 283, S^2) proceeds upwards with a slight inclination forwards into the lower part of the outer surface of the frontal lobe for a distance of about an inch or less. In many cases the two anterior limbs spring from a common stem of greater or less length (Fig. 283).

Limiting Sulcus of Reil (sulcus circularis Reilii).—If the lips of the Sylvian fissure be now gently but widely pulled asunder, the island of Reil or the central lobe will be seen at the bottom. This is surrounded by a limiting sulcus, of which we recognise three parts, viz., an *upper part* bounding it above, a *lower part* marking it off below, and an *anterior part* limiting it in front. The insula thus mapped out is somewhat triangular in form.

Opercula Insulæ.—The present is a good time to study the manner in which the insula is shut off from the surface of the hemisphere. When the fissure of Sylvius is held widely open, it will be observed that the insula is overlaid by portions of cerebral cortex which appear as if they were undermined. These by the approximation of their margins or lips form the three limbs of the fissure of Sylvius, and are termed the *insular opercula*. It will be noticed that the limbs of the Sylvian fissure cut right through between the different opercula, and extend from the surface of the hemisphere to the surface of the island of Reil. The opercula are four in number, and are named—(1) temporal, (2) fronto-parietal, (3) frontal, and (4) orbital. They are easily distinguished.

The *temporal operculum* extends upwards over the insula from the temporal lobe; it forms the lower lip of the posterior horizontal limb of the Sylvian fissure.

The *fronto-parietal operculum* is carried downwards over the insula to meet the temporal operculum. Its margin

forms the upper lip of the posterior horizontal limb of the fissure of Sylvius.

The *frontal operculum* (Fig. 283, B) is the small triangular piece of cerebral cortex between the ascending and anterior horizontal limbs of the Sylvian fissure. It is sometimes termed the *pars triangularis*.

The *orbital operculum* (Fig. 283, C) is for the most part on the under surface of the hemisphere. It lies below and to the inner side of the anterior horizontal limb of the fissure of Sylvius, and proceeds backwards from the orbital aspect of the frontal lobe over the fore part of the insula.

Fissure of Rolando (sulcus centralis).—The fissure of Rolando takes an oblique course across the outer convex surface of the cerebral hemisphere (Fig. 283, R). Its upper end cuts the supero-mesial border of the hemisphere a short distance behind the mid-point between the frontal and occipital poles, whilst its lower end terminates above the middle of the posterior horizontal limb of the fissure of Sylvius. Its superior extremity, as a rule, turns round the supero-mesial border of the hemisphere, and is then continued backwards for a short distance on its mesial surface (Fig. 284, R). Although in its general direction the fissure of Rolando is oblique, it is far from being straight. It takes a sinuous course across the hemisphere, and makes two bends, which are termed its genua. The *superior genu* is placed between its upper and middle thirds, and its concavity looks forwards. The *inferior genu* is situated in advance of the superior bend and a short distance lower down. Its convexity is directed forwards. The short portion of the fissure between the two genua is frequently very nearly horizontal in direction.

Parieto-occipital Fissure.—A very small part of this fissure appears on the outer face of the cerebral hemisphere (Fig. 283, O.P.). It is situated, for the most part, on the internal surface (Fig. 284, P.O.). It is customary, therefore, to describe an external parieto-occipital and an internal parieto-occipital fissure. At the same time, it must be clearly

understood that they are directly continuous with each other around the supero-mesial margin of the hemisphere.

The *external parieto-occipital fissure* cuts the supero-mesial border of the hemisphere in a transverse direction from one and a half to two inches in front of the occipital pole. It is usually not more than half-an-inch in length, and it is brought to an abrupt termination by an arching convolution which winds round its extremity, and receives the convenient name of *arcus parieto-occipitalis* (Fig. 283).

The *internal parieto-occipital fissure* (Fig. 284, *par.-occ.*) is carried downwards in a nearly vertical direction as a con-

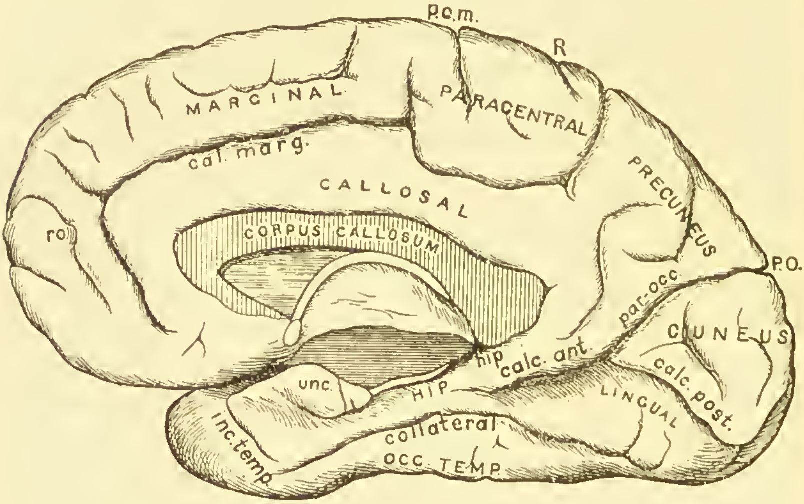


FIG. 284.—Mesial or internal surface of the right hemisphere of a female brain in which the convolutions are very simply arranged.

The names of the convolutions are printed in capitals, whilst the names of the fissures are printed in small type.

ro. Rostral sulcus.
cal.-marg. Calloso-marginal sulcus.
p.c.m. Sulcus præcentralis medialis.
R. Upper end of fissure of Rolando.
P.O. Parieto-occipital fissure.
par.-occ. Internal parieto-occipital fissure.
calc. ant. Anterior portion of the calcarine fissure.
calc. post. Posterior part of the calcarine fissure.
hip. Hippocampal fissure.
HIP. Hippocampal gyrus.
UNC. Uncus.
inc. temp. Incisura temporalis.

spicuous and deep cleft, which, by its lower end, runs into the calcarine fissure.

Collateral Fissure (Fig. 284).—The collateral fissure is a strongly marked fissure on the under surface of the tentorial part of the inferior surface of the cerebral hemisphere. It begins near the occipital pole, and extends forwards towards the temporal pole. In its posterior part it is placed below and parallel to the calcarine fissure, whilst in front it is separated from the hippocampal or dentate fissure by the hippocampal convolution, *i.e.*, the innermost convolution on the tentorial surface of the hemisphere (Fig. 284, HIP.).

In front of the anterior end of the collateral fissure a shallow sulcus will be seen turning round the anterior end of the temporal lobe so as to intervene between the temporal pole and the uncinate or hook-like extremity of the hippocampal gyrus. This is the *incisura temporalis*, and it may be regarded as a forward prolongation of the collateral fissure; at the same time, it must be admitted that the two are seldom continuous with each other.

The Calloso-marginal Fissure (Fig. 284, *cal.-marg.*) is a strongly marked sulcus on the fore part of the mesial surface of the hemisphere. It divides the front portion of the mesial surface into an upper marginal and a lower callosal convolution, and forms on this aspect the lower limit of the frontal lobe. Beginning below the fore end of the corpus callosum, close to the locus perforatus anticus, the calloso-marginal fissure curves round the genu of the corpus callosum, and then extends backwards to a point a short distance behind the middle of the supero-mesial surface. It then turns upwards and cuts the supero-mesial margin of the hemisphere immediately behind the upper end of the fissure of Rolando (Fig. 283, *c.m.*). The relation presented by the two extremities of these fissures is such that they can both be readily recognised, either when examined on the outer or the mesial aspect of the cerebrum.

Boundaries of the Frontal Lobe.—The frontal is the largest of the cerebral lobes. On the outer surface of the hemisphere it is bounded behind by the fissure of Rolando, and below, by the posterior horizontal limb of the fissure of Sylvius. On the mesial face it is limited by the calloso-marginal fissure, whilst on the inferior surface of the hemisphere the stem of the fissure of Sylvius forms its posterior boundary.

External Surface of the Frontal Lobe.—On the outer surface of the frontal lobe the following sulci and gyri may be recognised :—

Sulci	Gyri		
Sulcus præcentralis inferior.	Ascending frontal (or anterior central).		
Sulcus præcentralis superior.	Superior frontal.	Upper division.	
		Lower division.	
Sulcus paramedialis.	Middle frontal.	Upper division.	
Sulcus frontalis superior.		Lower division.	
Sulcus frontalis medius.	Inferior frontal.	Pars basilaris.	
Sulcus frontalis inferior.		Pars triangularis.	
Sulcus diagonalis.		Pars orbitalis.	
Sulcus fronto-marginalis.			

The *inferior præcentral furrow* (Fig. 283, *p.c.i.*) consists of a vertical and a horizontal part, and, when present in a well-marked form, it presents a figure like the letter T or F. The *vertical portion* lies in front of the lower part of the fissure of Rolando, whilst the *horizontal portion* extends obliquely forwards and upwards into the middle frontal convolution.

The *superior præcentral furrow* (Fig. 283, *p.c.s.*) is a short vertical sulcus which lies at a higher level than the inferior præcentral furrow, in front of the upper part of the fissure of Rolando. It is almost invariably connected with the hinder end of the superior frontal sulcus.

The *ascending frontal convolution* (gyrus centralis anterior) is a long continuous gyrus which is limited in front by the two præcentral furrows, and behind, by the fissure of Rolando. It extends obliquely across the hemisphere, from

the supero-mesial margin above to the posterior horizontal limb of the Sylvian fissure below (Fig. 283, C.A.).

The *superior frontal sulcus* (Fig. 283, f^1), extends forwards in a more or less horizontal direction from the sulcus præcentralis superior.

The *gyrus frontalis superior* (Fig. 283, F^1) is the narrow convolution between the supero-mesial border of the hemisphere and the superior frontal sulcus. It takes a horizontal course forwards to the frontal pole.

The *inferior frontal sulcus* (Fig. 283, f^2), occupies a lower level than the superior furrow of the same name. Its hinder end is placed in the angle between the vertical and horizontal parts of the inferior præcentral sulcus, and is not infrequently confluent with one or other of these. It proceeds forwards towards the superciliary margin of the hemisphere, and ends a short distance from this in a terminal bifurcation.

The *gyrus frontalis medius* (Fig. 283, F^2) is the broad convolution which lies between the superior and inferior frontal furrows.

The *gyrus frontalis inferior* (Fig. 283, F^3) is that portion of the outer surface of the frontal lobe which is placed in front of the inferior præcentral sulcus and below the inferior frontal sulcus.

The *sulcus paramedialis* (Fig. 283, *p.m.s.*), is the term applied to a series of short irregular furrows arranged longitudinally, close to the supero-mesial border of the hemisphere. These rudimentary sulci partially subdivide the superior frontal convolution into an upper and lower division, and are of interest in so far that they are best marked in high types of brain.

The *sulcus frontalis medius* of Eberstaller (Fig. 283, *f.m*), proceeds horizontally forwards in the fore part of the middle frontal convolution, so as to divide it into an upper and a lower part (Fig. 283, F^2S and F^2I). When it reaches the supercilary margin of the hemisphere it bifurcates, and its

terminal branches spread out widely from each other, and together constitute a transverse furrow called the sulcus fronto-marginalis (Wernicke).

Owing to the subdivision of the superior and middle frontal convolutions in the manner indicated, the typical arrangement of the convolutions in the anterior part of the outer surface of the frontal lobe is in five horizontal tiers, and not in three tiers as previously described.

The *inferior frontal convolution* possesses a very special interest and importance, on account of the localisation within it, on the left side, of the speech-centre. It is cut up into three parts by the two anterior limbs of the fissure of Sylvius. These are termed the pars basilaris, the pars triangularis, and the pars orbitalis.

The *pars basilaris* (Fig. 283, A), is that part which lies between the vertical limb of the inferior præcentral sulcus and the ascending limb of the Sylvian fissure. It forms the anterior portion of the fronto-parietal operculum, and it is traversed in an oblique direction by a shallow but constant furrow, termed the *sulcus diagonalis* (Fig. 283, *d*).

The *pars triangularis* (Fig. 283, B) is simply another name for the frontal operculum. It is triangular in form, and lies between the ascending and anterior horizontal limbs of the Sylvian fissure.

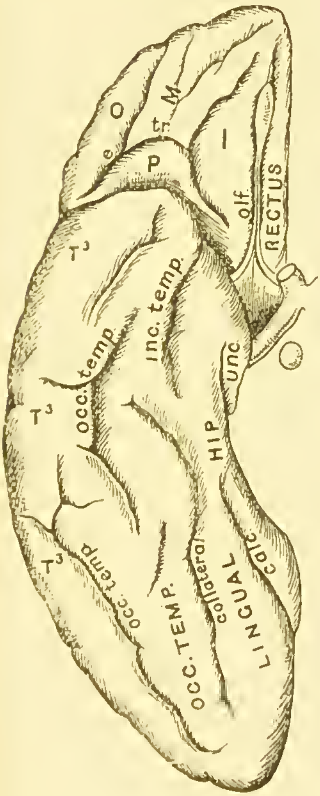
The *pars orbitalis* (Fig. 283, C) is placed below the anterior horizontal limb of the fissure of Sylvius.

Mesial Surface of the Frontal Lobe.—On this aspect of the frontal lobe there is an elongated, more or less continuous, convolution called the *gyrus marginalis*. It lies between the supero-mesial border of the hemisphere and the calloso-marginal fissure (Fig. 284). In the fore part of this gyrus one or two curved sulci are usually present. These are termed the *sulci rostrales* (Fig. 284, *ro*).

Further, the posterior part of the marginal convolution is more or less completely cut off from the portion which lies in front. This part is called the *paracentral lobule*, and

into it the upper end of the fissure of Rolando is prolonged, as it turns over the supero-mesial border of the hemisphere (Fig. 284).

Orbital Surface of the Frontal Lobe.—On this aspect of the frontal lobe there are two sulci—viz., the olfactory and the orbital.



e. External part of the orbital sulcus.
tr. Transverse part of the orbital sulcus.
olf. Olfactory sulcus.
O. Orbital part of the inferior frontal gyrus.
P. Posterior orbital convolution.
M. Anterior orbital convolution.
I. Internal orbital convolution.
T3. Inferior or third temporal convolution.
OCC. TEMP. Occipito-temporal convolution.
inc. temp. Incisura temporalis.
calc. Calcarine fissure.
HIP. Hippocampal convolution.
UNC. Uncus.

The names of the gyri are printed in capitals, whilst small type is used to indicate the fissures.

FIG. 285.—The inferior surface of the right cerebral hemisphere of a female brain.

The *olfactory sulcus* (Fig. 285, *olf*) is a straight furrow which runs parallel to the mesial border of the hemisphere. It is occupied by the olfactory tract and bulb, and it cuts off a narrow strip of the orbital surface close to the

mesial border which receives the name of *gyrus rectus* (Fig. 285).

The *orbital sulcus* (tri-radiate sulcus of Turner) is a compound furrow which assumes many different forms. Most frequently it takes the shape of the letter H, and we then recognise three component parts—viz., an external limb, an internal limb, and a transverse limb.

The *external limb* (sulcus orbitalis externus) curves round the orbital part of the inferior frontal gyrus, so as to limit it internally (Fig. 285, *e*). The *internal limb* (sulcus orbitalis internus) marks off a convolution between itself and the olfactory sulcus which receives the name of *gyrus orbitalis internus* (Fig. 285, I). The *transverse limb* or sulcus orbitalis transversus (Fig. 285, *tr*) takes a curved course with the concavity directed backwards. It divides the district between the external and internal limbs into an anterior part, or *gyrus orbitalis anterior* (Fig. 285, M), and a posterior part, or *gyrus orbitalis posterior* (Fig. 285, P). The latter corresponds with the greater part of the orbital operculum.

Boundaries of the Parietal Lobe.—The parietal lobe forms a considerable part of the external face of the cerebral hemisphere, and it also appears on the mesial face in the form of the præcuneus or quadrate lobule. *In front*, it is bounded by the fissure of Rolando, which separates it from the frontal lobe. *Below*, it is bounded in its fore part by the posterior horizontal limb of the Sylvian fissure. Behind the upturned end of this fissure it is quite continuous inferiorly with the temporal lobe, and an arbitrary line drawn backwards on the surface of the brain in continuation of the horizontal part of the posterior limb of the fissure of Sylvius is taken as its inferior limit (Fig. 283). *Posteriorly*, it is separated from the occipital lobe at the supero-mesial border of the hemisphere by the external parieto-occipital fissure. Below this it is more or less directly continuous with the occipital lobe, and an arbitrary line drawn across the outer surface of the hemisphere from the extremity of

the external parieto-occipital fissure to an indentation on the infero-lateral border of the hemisphere, termed the *præoccipital notch*, may be regarded as furnishing a posterior limitation. The præoccipital notch is, as a rule, only visible in brains that have been hardened *in situ.* It is produced by a slight wrinkle or fold of the dura mater on the deep aspect of the parieto-mastoid suture, and in relation to the portion of the lateral venous sinus which lies in this locality. The notch is placed on the infero-lateral border of the hemisphere, about one inch and a-half in front of the occipital pole.

Mesial Surface of the Parietal Lobe—Præcuneus.—On the mesial surface of the hemisphere the parietal lobe is represented by the *præcuneus* or *quadrate* lobule. This district, which is somewhat quadrilateral in form, lies between the upturned hinder end of the calloso-marginal fissure and the internal parieto-occipital fissure. Below it is imperfectly separated from the limbic lobe by a somewhat variable sulcus called the *post-limbic sulcus* (Fig. 284).

External Surface of the Parietal Lobe.—The gyri and sulci on the outer surface of the parietal lobe are the following :—

- Gyri
  - Ascending parietal or postcentral.
  - Superior parietal lobule.
  - Inferior parietal lobule.
    - Supra-marginal.
    - Angular.
    - Postparietal.
- Sulci
  - Intra-parietal of Turner.
    - Sulcus postcentralis inferior.
    - Sulcus postcentralis superior.
    - Ramus horizontalis.
    - Ramus occipitalis.
  - Upturned ends of—
    - (*a.*) Sylvian.
    - (*b.*) Parallel.
    - (*c.*) Second temporal.

The Intraparietal Sulcus of Turner.—This is a composite sulcus built up out of four originally distinct factors. Two of these, termed the sulcus postcentralis inferior and the sulcus postcentralis superior, take a more or less vertical course across the hemisphere, and are most frequently

continuous with each other. The other two factors are placed horizontally one behind the other, and they are called the ramus horizontalis and the ramus occipitalis.

The *sulcus postcentralis inferior* (Fig. 286, p^1) lies behind the lower part of the fissure of Rolando, whilst the *sulcus postcentralis superior* (Fig. 286, p^2) occupies a similar position in relation to the upper part of that fissure. When confluent with each other they form a long continuous

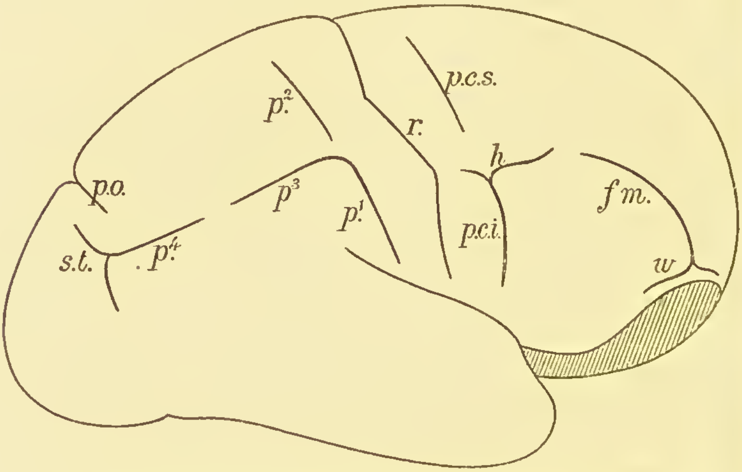


FIG. 286.—Diagram to show the correspondence between the præcentral and intraparietal systems of furrows.

r. Fissure of Rolando.
p.c.s. Sulcus præcentralis superior.
p.c.i. Sulcus præcentralis inferior.
h. Ramus horizontalis of sulcus præcentralis inferior.
f.m. Sulcus frontalis medius.
w. Fronto-marginal sulcus.
*p*1. Sulcus postcentralis inferior.
*p*2. Sulcus postcentralis superior.
*p*3. Ramus horizontalis of intraparietal sulcus.
*p*4. Ramus occipitalis.
s.t. Sulcus occipitalis transversus.
p.o. External parieto-occipital fissure.

furrow, which stretches across the hemisphere behind the fissure of Rolando and parallel to it (Fig. 283, p^1 and p^2).

The *ramus horizontalis* (Fig. 286, p^3) is continuous with the upper end of the sulcus postcentralis inferior, and extends backwards, with a slight inclination upwards, between the superior parietal lobule, which lies above it, and the inferior parietal lobule, which lies below it. With the two

confluent postcentral sulci it presents a figure like the letter ⊣ placed on its side.

The *ramus occipitalis* (Figs. 283 and 286, p^4) is a curved sulcus which bounds externally the arcus parieto-occipitalis, or in other words, the arching convolution which surrounds the external parieto-occipital fissure. Sometimes the ramus occipitalis is linked on to the ramus horizontalis—more frequently it is separate. Its posterior end runs into the occipital lobe, and behind the arcus parieto-occipitalis it bifurcates into two widely spread-out branches. These form a short transverse fissure in the occipital lobe, termed the *sulcus occipitalis transversus* (Ecker) (Figs. 283 and 286, *s.t.*).

The upturned ends of the posterior horizontal limb of the fissure of Sylvius (Fig. 283, *s. asc.*), of the parallel or first temporal fissure (Fig. 283, t^1. *asc.*) and of the second temporal sulcus (Fig. 283, t^2. *asc*) extend for a short distance, one behind the other, into the inferior parietal lobule.

Gyri on the External Surface of the Parietal Lobe.—The intraparietal sulcus maps out three districts or areas on the outer surface of the parietal lobe. These are the ascending parietal convolution and the superior and inferior parietal lobules.

The *ascending parietal convolution* or *gyrus centralis posterior* (Fig. 283, C.P.) is a long gyrus which extends obliquely across the hemisphere from the supero-mesial border above to the posterior limb of the Sylvian fissure below. In front it is bounded by the fissure of Rolando, and behind by the superior and inferior postcentral furrows.

The *superior parietal lobule* is the area of cerebral cortex which lies between the ramus horizontalis below and the supero-mesial border of the hemisphere above. In front it is bounded by the superior postcentral sulcus, whilst behind it is connected with the occipital lobe by the arcus parieto-occipitalis. It is continuous around the supero-mesial border of the hemisphere with the præcuneus.

The *inferior parietal lobule* lies below the ramus horizon-

talis and the ramus occipitalis, and behind the inferior postcentral furrow. It is more or less directly continuous with the occipital lobe behind and the temporal lobe below. From before backwards it presents three arching convolutions, viz., the supra-marginal, the angular, and the post-parietal.

The *supra-marginal convolution* (Fig. 283) is folded round the upturned end of the posterior limb of the fissure of Sylvius, and stands in continuity with the first temporal convolution. The *angular gyrus* (Fig. 283) arches over the upturned end of the parallel or first temporal sulcus, and is continuous with the second temporal convolution. The *post-parietal convolution* (Fig. 283) winds round the upturned end of the second temporal sulcus, and runs into the third temporal gyrus.

Boundaries of the Occipital Lobe.—The occipital lobe forms the hinder pyramidal part of the cerebral hemisphere, and it may be defined as being that portion of the hemisphere which encloses the posterior horn of the lateral ventricle. On the surface it is very imperfectly mapped off from the parietal and temporal lobes which lie in front of it. Being pyramidal in form, it presents three surfaces and an apex or occipital pole. On the mesial aspect of the hemisphere it is separated from the parietal lobe (*i.e.*, the præcuneus) by the internal parieto-occipital fissure. On the tentorial or inferior surface it is not marked off in any way from the temporal lobe and the hippocampal part of the limbic lobe which lie in front of it. It is necessary, therefore, on this aspect to employ an arbitrary line of demarcation; one which extends from the præoccipital notch on the infero-lateral border of the hemisphere to the isthmus of the limbic lobe (*i.e.*, the narrow part of the limbic lobe immediately below the hinder end of the corpus callosum) will serve the purpose. On the external surface the external parieto-occipital fissure and an arbitrary line from this to the præoccipital notch may be regarded as separating the occipital from the parietal

and temporal lobes. As a general rule, the upturned end of the second temporal sulcus lies in the course of this line, and may in these cases be considered as a bounding furrow.

Mesial Aspect of the Occipital Lobe.—On this surface we find (1) the calcarine fissure; (2) the cuneus; and (3) the gyrus lingualis.

The *calcarine fissure* begins by a bifurcated extremity in the groove for the lateral sinus on the occipital pole. From this it pursues a slightly arched course forwards, and ends by cutting into the limbic lobe immediately below the thickened posterior extremity (splenium) of the corpus callosum. The calcarine fissure is joined by the internal parieto-occipital fissure at a point somewhat nearer its anterior than its posterior extremity. Together the two fissures present a -<-shaped figure.

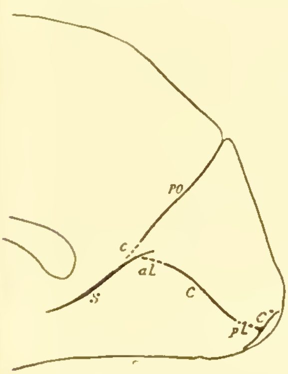


FIG 287.—Diagram of the parieto-occipital and calcarine fissures.

P.O. Parieto-occipital fissure.
c. Gyrus cunei.
a.l. Anterior cuneo-lingual gyrus.
S. Anterior calcarine fissure.
C.C″. Posterior calcarine fissure.

If the calcarine and internal parieto-occipital fissures be fully opened up, so as to expose the bottom in each case, two well-marked deep or submerged gyri will be displayed. One of these, the *gyrus cunei*, marks off the parieto-occipital fissure from the calcarine fissure; the other interrupts the calcarine fissure immediately behind its junction with the parieto-occipital. It is called the *anterior cuneo-lingual deep gyrus*, and it divides the calcarine fissure into an anterior and a posterior part. The *anterior calcarine fissure* corresponds very nearly to the stem of the -<-shaped fissural arrangement. It is very deep, and being a complete fissure, it gives rise to an elevation on the inner wall of the posterior horn of the lateral ventricle, called the calcar avis or the hippocampus minor. The *posterior calcarine fissure* is much shallower.

The *cuneus* (Fig. 284) is the wedge-shaped or triangular district on the mesial aspect of the occipital lobe which

lies between the internal parieto-occipital and calcarine fissures.

The *gyrus lingualis* (Fig. 284) is a well marked convolution between the calcarine fissure above and the posterior part of the collateral fissure below, which stretches forwards from the occipital pole. Anteriorly it becomes very narrow, and joins the hippocampal part of the limbic lobe. It lies partly on the mesial and partly on the tentorial surface of the occipital lobe.

Tentorial Surface of the Occipital Lobe.—On this aspect there is only one convolution, viz., the posterior part of the *occipito-temporal gyrus* (Fig. 285). It proceeds continuously forwards into the temporal lobe on the outer side of the collateral fissure, and it is bounded externally by the *occipito-temporal sulcus*—a furrow which is rarely continuous, but is usually represented by a series of detached pieces.

The External Surface of the Occipital Lobe.—There are two well marked sulci on this face of the occipital lobe—viz., the sulcus occipitalis transversus and the sulcus occipitalis lateralis.

The *sulcus occipitalis transversus* (Fig. 282, *s.t.*) extends transversely across the upper part of the lobe behind the arcus parieto-occipitalis. It has already been described as the terminal bifurcation of the ramus occipitalis of the intraparietal sulcus of Turner.

The *sulcus occipitalis lateralis* (Fig. 282, *occ. lat.*) is a short horizontal furrow which divides the outer surface of the lobe into an upper and a lower area of very nearly equal extent. These areas are connected by means of superficial annectant gyri with the parietal and temporal lobes.

The Boundaries of the Temporal Lobe.—The temporal lobe lies behind the stem and below the posterior horizontal limb of the fissure of Sylvius. It is somewhat pyramidal in form, and presents an upper, an outer, and a tentorial surface, with a free projecting apex or pole. Above, it is bounded by the posterior horizontal limb of the

fissure of Sylvius, together with the artificial line which is drawn backwards from this. On the tentorial surface it is separated from the hippocampal part of the limbic lobe by the collateral fissure, whilst behind, it is marked off from the occipital lobe by the arbitrary lines already described (p. 514). The apex or temporal pole projects forwards on the under surface of the brain beyond the stem of the Sylvian fissure. It should be noticed that the recurved extremity of the hippocampal part of the limbic lobe (uncus) which lies to the inner side of the temporal pole does not project so far forwards as the latter, and is separated from the pole by the *incisura temporalis.* This sulcus may be regarded as the connecting link between the anterior ends of the collateral fissure and the inferior limiting sulcus of Reil.[1]

Upper or Opercular Surface of the Temporal Lobe.—This is the surface of the temporal operculum which is opposed to the island of Reil and the fronto-parietal operculum. The fissure of Sylvius must therefore be widely opened up to expose it. For the most part the surface is smooth, but towards its back part there are a few shallow transverse furrows, called the *sulci of Heschl*, whilst in front, on the deep aspect of the temporal pole, two or three furrows are also evident.

Outer Surface of the Temporal Lobe.—On this aspect of the lobe there are two horizontal sulci, called respectively the first temporal, or parallel, and the second temporal sulcus.

The *parallel sulcus* (Fig. 282, t^1) is a long continuous and deep fissure which begins near the temporal pole, and proceeds backwards below the posterior limb of the Sylvian fissure. Its hinder end turns upwards into the parietal lobe, and is surrounded by the angular gyrus.

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[1] The importance of this connection is evident when we remember that, strictly speaking, the inferior limiting sulcus of Reil is the true upper limit of the temporal lobe.

The *second temporal sulcus* is placed midway between the parallel sulcus and the infero-lateral border of the hemisphere. It is very rare to find it in the form of a continuous cleft. Usually it is broken up into several isolated pieces, placed one behind the other. Its hinder part, which turns upwards into the parietal lobe (Fig. 283, t^2 *asc.*), and is surrounded by the post-parietal gyrus, lies close to the artificial line of demarcation between the occipital and parietal lobes.

By the two temporal sulci the outer surface of the temporal lobe is mapped out into three tiers of horizontal convolutions, which are termed the *first*, *second*, and *third temporal gyri* (Fig. 283, T^1 T^2 and T^3).

Tentorial Surface of the Temporal Lobe.—On this surface there is one fissure, termed the occipito-temporal sulcus.

The *occipito-temporal sulcus* (Fig. 285, *occ. temp.*) lies to the outer side of the collateral fissure and close to the infero-lateral border of the hemisphere. It runs in an antero-posterior direction, and is not confined to the temporal lobe, but extends backwards towards the occipital pole. It is usually broken up into two or more separate pieces.

The *occipito-temporal convolution* (Fig. 285) is situated between the collateral fissure and the occipito-temporal sulcus. It extends from the occipital pole behind to the temporal pole in front.

The narrow strip of surface on the outer side of the occipito-temporal sulcus is continuous round the infero-lateral margin of the hemisphere with the third temporal convolution on the outer surface of the cerebrum, and may be reckoned as a part of it.

The three temporal convolutions and the occipito-temporal convolution run into each other at the temporal pole.

The Island of Reil or Insula.—The insula is a triangular field of cerebral cortex which lies on a deeper plane than the general surface of the hemisphere, and is hidden from view by the four opercula which overlap it (p. 506). It is

bounded by a distinct limiting sulcus (sulcus circularis Reilii) which has already been described, and its dependent apical part, which looks downwards, is in close relation to the Sylvian vallecula and the anterior perforated spot on the base of the brain.

The insula is divided into several diverging convolutions by a series of radiating sulci. Of the latter, one, which pre-

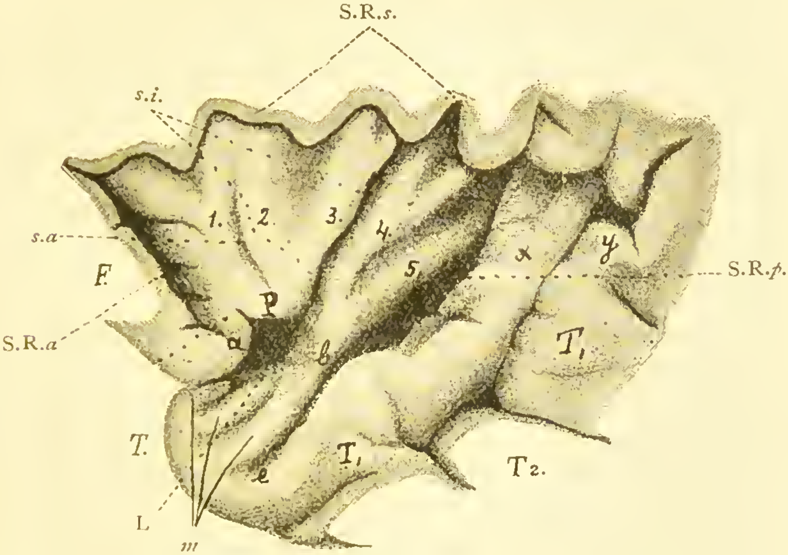


FIG. 288.—Fissures and gyri on the surface of the insula. (EBERSTALLER).

1, 2, and 3. Three short gyri on the frontal part of the insula.
4 and 5. Two gyri on parieto-limbic part.
S.R.*a*. Anterior limiting sulcus.
S.R.*s*. Superior limiting sulcus.
S.R.*p*. Inferior limiting sulcus.
L. Limen insulæ.
P. Pole of the insula.
F. Orbital operculum (for the most part removed).
T. Temporal pole.
T1. First temporal gyrus.
T2. Second temporal gyrus.
x.y. Gyri of Heschl.
s.i. Sulcus centralis insulæ.
s.a. Sulcus præcentralis insulæ.
m. Gyri on deep surface of temporal pole.

sents the same direction and lies in the same plane as the fissure of Rolando, receives the name of the *sulcus centralis insulæ.* It divides the insula into an anterior *frontal part* and a posterior *parieto-limbic portion.*

Olfactory Lobe.—The olfactory lobe is small and rudimentary in the human brain. It is described by His as consisting of a *posterior lobule*, which may be said to correspond with that part of the cerebral cortex which is named the locus perforatus anticus, and an *anterior lobule* composed of (1) the olfactory bulb and tract, with the two roots of the latter; (2) the trigonum olfactorium; and (3) the area of Broca.

The *olfactory tract* is a narrow white prismatic band, which expands anteriorly into a swollen bulbous extremity termed the *olfactory bulb.* Both the tract and the bulb lie upon the olfactory sulcus on the orbital surface of the frontal lobe, whilst the inferior surface of the bulb rests on the cribriform plate of the ethmoid bone, and receives the numerous olfactory nerves which reach it through the foramina in that part of the cranial floor.

Posteriorly, the olfactory tract will be seen to divide into two diverging roots of attachment. The *mesial root* curves abruptly inwards, and may be followed into the extremity of the callosal gyrus (*i.e.*, the anterior end of the limbic lobe). The *lateral root* runs backwards and outwards over the outer part of the locus perforatus anticus, and gradually disappears from view. In animals in which the olfactory apparatus is better developed than in man, it may be traced into the uncinate extremity of the hippocampal convolution (*i.e.*, posterior end of the limbic lobe).

The *trigonum olfactorium* is the little triangular field of grey matter which occupies the interval between the roots of the olfactory tract at the point where they begin to diverge.

The *area of Broca* lies in front of the curved mesial root of the olfactory tract, and is continuous with the commencement of the callosal gyrus.

Limbic or Falciform Lobe.—This lobe is seen on the mesial surface of the hemisphere, in the form of an elongated ring-like convolution, the extremities of which approach

closely to each other at the locus perforatus anticus. These extremities have been seen to be connected by the roots of the olfactory tract, and in this manner the limbic ring may be considered to be closed.

The upper part of the limbic lobe is placed in intimate relation to the extremities and upper surface of the corpus callosum, and receives the name of *callosal convolution* or *gyrus fornicatus.* The lower portion of the lobe, termed the *hippocampal convolution*, forms the inner part of the tentorial face of the hemisphere. Behind, the hippocampal gyrus is connected with the callosal convolution by a narrow portion termed the *isthmus.* From this it extends forwards towards the temporal pole. Finally, on the side of the crus cerebri, the hippocampal convolution is folded back on itself, and ends in a recurved hook-like extremity, termed the *uncus.* The uncus does not reach so far forwards as the temporal pole.

The *callosal convolution* begins below the anterior end of the corpus callosum at the locus perforatus anticus, and winding round the genu of the callosum, it is continued backwards on its upper surface to the hinder thickened extremity or splenium. Finally, curving round this it becomes greatly narrowed through the calcarine fissure cutting into it. This narrow part is termed the *isthmus*, and constitutes the link of connection between the callosal gyrus and the hippocampal gyrus.

The callosal gyrus is separated from the marginal convolution by the calloso-marginal fissure. Behind this it is very imperfectly marked off from the præcuneus by the post-limbic sulcus. From the corpus callosum it is separated by the *callosal sulcus.*

The *hippocampal convolution* is bounded on the outer side by the anterior part of the collateral sulcus, and in front of this by the incisura temporalis, which separates its hooked extremity, or uncus, from the temporal pole. On its inner side it is limited by the hippocampal or dentate fissure,

whilst posteriorly, it is divided into two parts by the anterior extremity of the calcarine fissure. Of these, the upper is the isthmus, which connects it with the callosal gyrus, whilst the lower portion brings it into direct continuity with the gyrus lingualis or infracalcarine convolution.

If the dentate fissure which lies along the inner side of the hippocampal convolution be now opened up, the *gyrus dentatus* and the *fimbria* lying side by side will be brought into view.

The Fimbria (Fig. 289, *f.i.*) is simply a portion of the posterior pillar of the fornix prolonged into this region. It is a conspicuous band of white matter, which presents a prominent free border. In front it runs into the recurved extremity of the uncus, whilst, if it be traced backwards, it will be seen to curve upwards behind the posterior end of the optic thalamus and become continuous with the posterior pillar of the fornix below the hinder part of the corpus callosum.

If the handle of a scalpel be passed deeply into the brain above the fimbria, it passes directly into the descending horn of the lateral ventricle. The gap through which it is introduced is a part of the *great transverse fissure* of the brain.

The Gyrus Dentatus (dentate fascia) is a fine free edge of grey matter, which is placed between the fimbria and the deep part of the upper surface of the hippocampal convolution. It is slightly notched along the margin, whilst its surface is scored by numerous parallel and closely-placed transverse grooves. It begins behind in the region of the splenium (the thickened posterior end of the corpus callosum), and it is carried forwards into the cleft of the uncus.

Dentate Fissure.—This is a complete fissure, and the elevation on the ventricular wall, which corresponds to it, is called the hippocampus major(Fig. 289, *c.A.*). It begins behind the splenium of the corpus callosum, where it is continuous with a shallow part of the callosal fissure, and it proceeds forwards between the gyrus dentatus and the

hippocampal convolution. Its anterior end is enclosed within the uncus.

Dissection.—A dissection should now be made with the view of exposing the upper surface of the corpus callosum—the commissural band which stretches across between the cerebral hemispheres at the bottom of the great longitudinal fissure. With a long knife slice off the top of the right hemisphere at the level of the calloso-marginal fissure. The white medullary centre of the cerebral hemisphere, enclosed on all hands by the grey cortex, is brought very conspicuously into view, and the

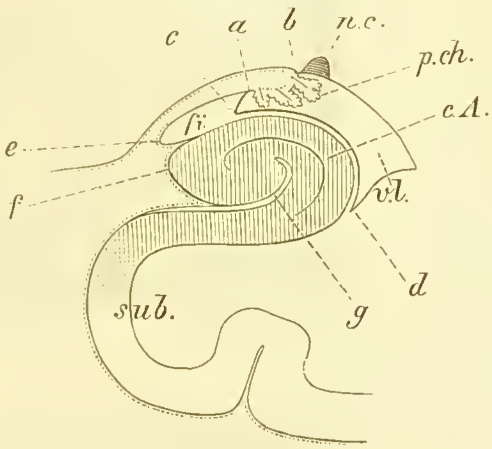


FIG. 289.—Diagram of a transverse section through the hippocampal convolution and the dentate fissure which lies internal to it. (From SCHWALBE.)

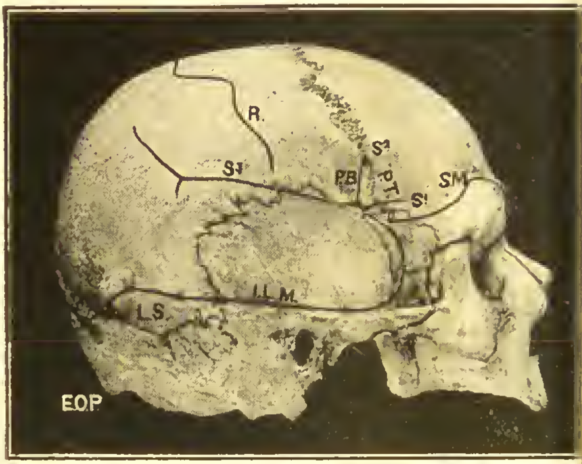
v.l. Descending horn of lateral ventricle.
sub. Hippocampal gyrus.
c.A. Hippocampus major.
c. White matter prolonged downwards from the posterior pillar of the fornix.
fi. Fimbria.
a-b. Choroid plexus.
p.ch. Epithelial wall of the ventricle covering choroid plexus.
n.c. Tail of caudate nucleus.
f. Gyrus dentatus.
g. Lamina medullaris involuta.

appearance receives the name of *centrum ovale minus*. From the central white mass medullary prolongations proceed into all the convolutions.

A transverse incision may next be made through the middle of the callosal convolution, and insinuating the fingers gently under it, the dissector should proceed to tear it away from the hemisphere in an outward direction. If this be carried out successfully, the manner in which the fibres of the corpus callosum enter the hemisphere will be seen. In cases where the student is dissecting the brain for the second time, the

knife should not be used at all in carrying out this dissection. The top of the hemisphere down to the level of the calloso-marginal fissure should, in the first instance, be torn off, and then the callosal convolution may be treated in the same way. By this expedient the fibres of the callosum may be traced into the convolutions.

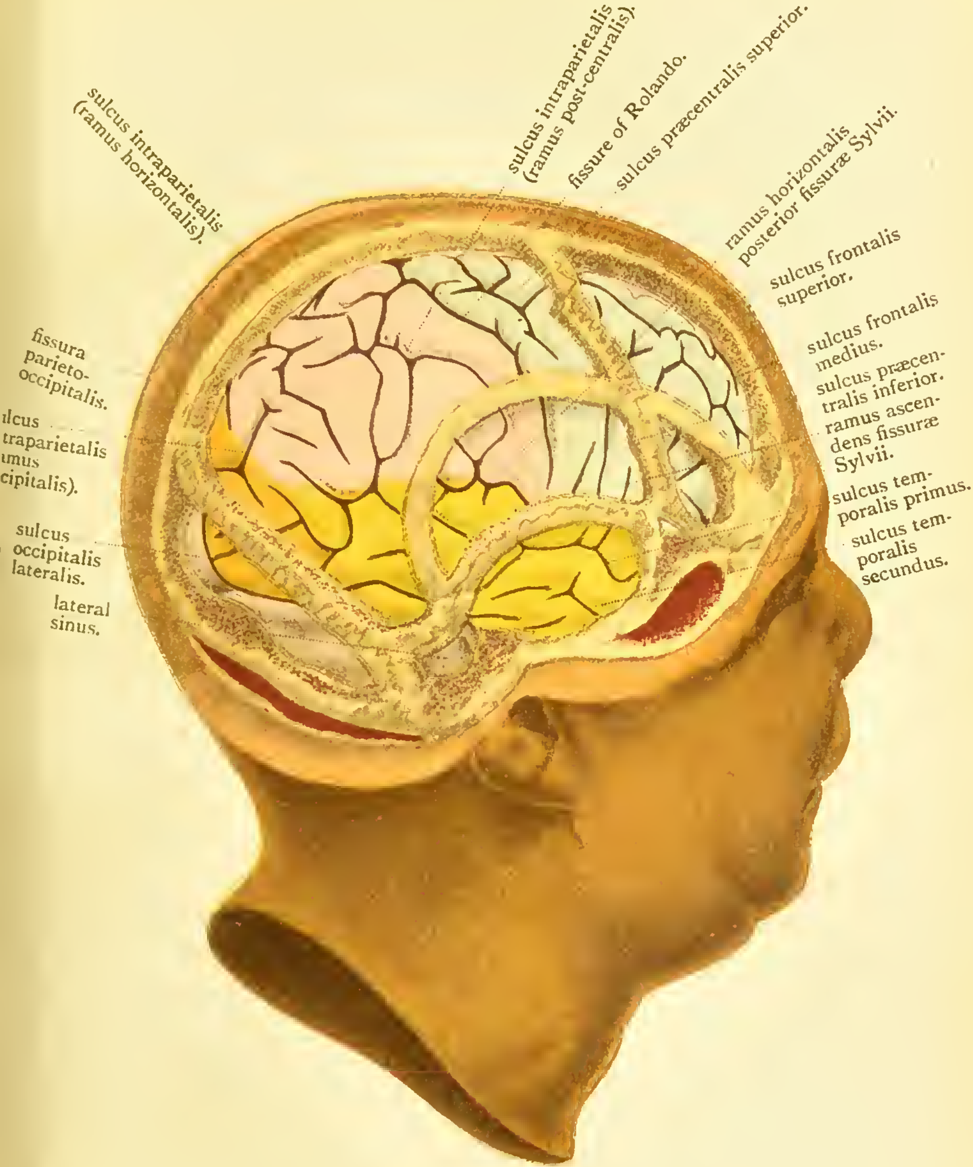
E.O.P. External occipital protuberance.
S.M. Supraciliary margin of the cerebrum.
I.L.M. Infero-lateral margin of the cerebrum.
L.S. Position of the highest part of the arch of the lateral sinus.
R. Fissure of Rolando.
S1. Anterior horizontal limb of Sylvian fissure.
S2. Anterior ascending limb of Sylvian fissure.
S3. Posterior horizontal limb of Sylvian fissure.
P.B. Pars basilaris of the inferior frontal convolution.
P.T. Pars triangularis of the inferior frontal convolution.
P.O. Pars orbitalis of the inferior frontal convolution.



A.

B.

FIG. 290.—To show the relation of the infero-lateral and the supraciliary borders of the cerebral hemisphere to the surface of the cranium.



The head of an adult female, 35 years of age, in which the brain is exposed *in situ.* Bars of bone are left along the lines of the cranial sutures, and also along the line of the temporal ridge.

Frontal lobe, . . .	blue.	Occipital lobe, . . .	brown.
Parietal lobe, . . .	pink.	Temporal lobe, . . .	yellow.

The two figures which precede this paragraph show the relation of the infero-lateral and the supraciliary borders of the cerebral hemisphere to the surface of the cranium. In A. a profile view of the skull is given; in B. the skull is turned so that it is viewed from the front as well as from the side. The outline of the cerebrum was obtained by perforating the cranium from the inside along the border of the hemisphere with a fine drill. The manner in which the infero-lateral border of the fore part of the temporal lobe is depicted in both figures is perhaps somewhat misleading. It is very difficult to say at this point what is the infero-lateral border of the hemisphere: the outer surface passes insensibly into the inferior or basal surface. It must be clearly understood, therefore, that the line immediately above the zygomatic arch does not indicate the deepest part of this portion of the temporal lobe. The extremity of the lobe curves downwards and inwards, and attains a depth considerably below the level of the upper border of the zygomatic arch.

The Cingulum.—If the deep surface of the callosal convolution which has been torn away be examined, a large bundle of longitudinally directed fibres will be noticed embedded in its substance. This is the cingulum. It can be easily dislodged, and a very slight degree of traction is all that is required to lift it out of its bed. In front it begins at the locus perforatus anticus, whilst behind it turns round the hinder end of the callosum, and enters the hippocampal convolution. It belongs, therefore, to the limbic lobe.

Dissection.—The gyri and sulci on the mesial surface of the left hemisphere may now be studied, and then the dissection, which has been carried out with the view of exposing the corpus callosum, may be repeated on the left side. In doing this, however, take care not to injure the mesial surface of the left hemisphere further back than the parieto-occipital fissure. Indeed, an effort should be made to preserve that fissure intact, so that it and the cuneus may be afterwards studied on this side in connection with the gyri and sulci on the under surface of the hemisphere.

The upper surface of the corpus callosum is now exposed, and it will be seen that, stretching between the two hemispheres, it unites into one mass the two medullary centres of the two hemispheres. The continuous white field, consisting of the corpus callosum and the medullary centre of each hemisphere, receives the name of *centrum ovale majus.*

Corpus Callosum.—This is the great transverse commissure of the cerebrum. It is placed nearer the anterior than

the posterior end of the brain, and it unites the inner surfaces of the two cerebral hemispheres throughout very nearly a half of their antero-posterior length. Looked at as a whole, it is highly arched from before backwards, and presents a convex upper surface and a concave lower surface.

The *upper surface* of the corpus callosum forms the bottom of the great longitudinal fissure, and on each side of this it is covered by the callosal convolution. Only in its posterior

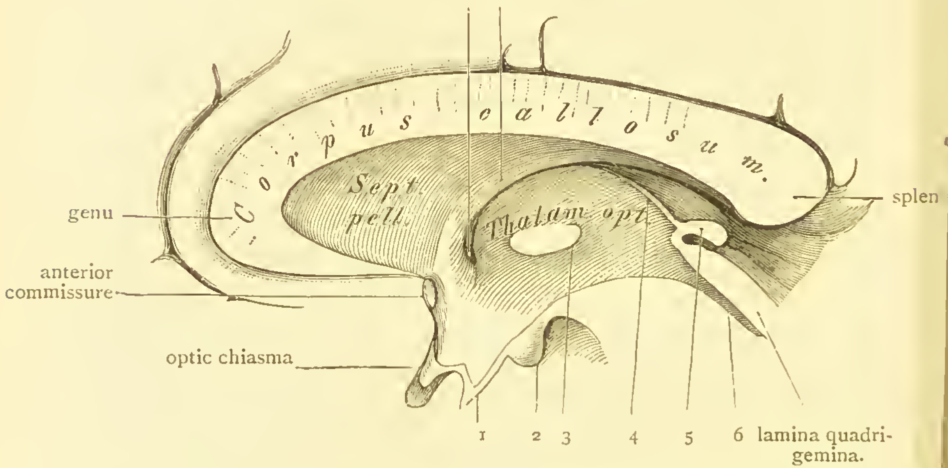


FIG. 291.—Mesial section through the corpus callosum and the parts subjacent to it. (From GEGENBAUR.)

1. Infundibulum.
2. Corpus mammillare.
3. Grey commissure.
4. Tænia fornicis.
5. Pineal body.
6. Aqueduct of Sylvius.

part is it touched by the falx cerebri; in front, this process of dura mater falls considerably short of it. The upper surface of the callosum is streaked in the transverse direction—an indication that this structure is for the most part composed of transversely directed bundles of nerve-fibres passing from one hemisphere to the other. Certain longitudinal markings are also evident in cases where the brain has been carefully preserved. In the mesial plane there is a shallow longitudinal groove, termed the *raphe*. On either side of

this there is a low-lying but distinct ridge, formed by a slender white tract of nerve fibres, called the *stria longitudinalis medialis*. Again, to the outer side of this, and under cover of the callosal gyrus, there are other feebly marked longitudinal ridges, termed the *striæ longitudinales laterales*.

The two *extremities* of the corpus callosum (Fig. 291) are greatly thickened, whilst the intermediate part, often called *the body*, is considerably thinner. The massive posterior

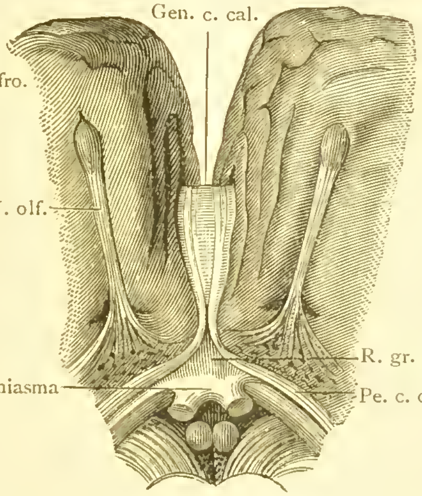


FIG. 292.—Anterior end of the corpus callosum and its peduncles, as seen from below when the hemispheres are slightly separated from each other. (From CRUVEILHIER.)

Gen. c. cal. Genu of the corpus callosum.
Lo. fro. Frontal lobe.
Chiasma. Optic chiasma.
Pe. c. cal. Peduncle of corpus callosum.
R. gr. opt. Lamina cinerea.
N. olf. Olfactory tract.

end, which is full and rounded, lies over the mesencephalon, and extends backwards as far as the highest point of the cerebellum. It is called the *splenium*. The anterior end, which is not quite so massive, is folded downwards and backwards upon itself, and is called the *genu*. The recurved lower portion of the genu is separated from the part of the corpus callosum which lies above by an interval; it rapidly thins as it passes backwards, and is termed the *rostrum*.

The fine terminal edge of the rostrum has already been seen to be connected with the lamina cinerea.

Both the lateral and the mesial longitudinal striæ, when traced backwards, are seen to turn round the splenium, and run into the corresponding gyrus dentatus. In front, the mesial striæ are carried round the genu, and then backwards on the under surface of the rostrum. Finally, diverging from each other, they receive the name of the *peduncles of the corpus callosum*. Each of these proceeds backwards and outwards along the posterior limit of the anterior perforated spot to the anterior extremity of the temporal lobe.

To some extent the direction which is taken by the fibres of the corpus callosum, as they radiate outwards into each cerebral hemisphere to reach the convolutions, is seen in the present dissection. Two sets of fibres are more conspicuous than the others. One of these, the *forceps minor*, proceeding from the genu, curves forwards into the fore part of the frontal lobe; the other, called the *forceps major*, issues from the under part of the splenium, and takes a bold sweep backwards into the occipital lobe. The term *tapetum* is given to a layer of fibres which comes from the body of the corpus callosum, and curves outwards and downwards so as to roof over and form the outer walls of the descending and posterior cornua of the lateral ventricle

Dissection.—The lateral ventricle in the interior of the cerebral hemisphere should now be opened up on each side. The corpus callosum, which forms the roof the body and anterior horn of this cavity, must therefore be partially removed. Make a longitudinal incision through this structure about half-an-inch or less from the mesial plane on each side. The central portion of the corpus callosum which lies between these incisions is to be kept in position. The lateral portions must be turned outwards and detached completely. As this is being done, it will become evident that the lower part of the splenium which is prolonged into the forceps major is in reality a portion folded forwards in close apposition with the under surface of the hinder end of the corpus callosum. Be careful to leave the forceps major in its place.

The body and the anterior horn of the ventricle are now exposed; but the cavity of the ventricle is carried backwards into the occipital lobe in the form of a posterior horn, and downwards and forwards into the temporal lobe in the form of the descending horn. The posterior horn can only at present be opened on the right side. Carry the knife backwards through the medullary substance which forms its roof, and remove

a sufficient amount of this to give a complete view of the interior of this part of the cavity. Greater difficulty will be experienced in opening up the descending horn. Place the point of the knife in the upper part of the horn where it joins the body of the ventricle, and carry the blade in a downward and forward direction through the outer part of the temporal lobe towards the temporal pole, following the course of the cavity. This corresponds very nearly with the course of the parallel fissure. The outer wall of the descending horn is thus incised, and a sufficient amount of the outer part of the temporal lobe must be removed to give a view of the cavity. In doing this, the temporal operculum will be taken away, but the surface of the insula should be preserved from injury.

Lateral Ventricle.—The dissector will now perceive that each cerebral hemisphere is hollow. The cavity in the interior is called the lateral ventricle, and is lined by a thin layer of dark coloured material, which is termed the *ependyma*. In health the walls of the cavity are in most localities more or less closely applied to each other, and within the space there is only a small amount of *cerebro-spinal fluid*. The lateral ventricle communicates with the third ventricle of the brain by means of a small foramen, just large enough to admit a crow-quill, which is termed the *foramen of Monro*. This aperture is placed in front of the fore end of the optic thalamus, and behind the anterior pillar of the fornix.

The shape of the lateral ventricle is very irregular, and can be best understood by the study of a plaster cast of its interior (Fig. 293). It is divided into a body and three horns, viz., an anterior, a posterior, and a descending horn. The description of an anterior horn is highly artificial. The *anterior horn* is that part of the cavity which lies in front of the foramen of Monro. The *body* is the portion of the ventricle which extends from the foramen of Monro to the splenium of the corpus callosum. At this point the posterior and descending horns diverge from the hinder end of the body. The *posterior horn* curves backwards and inwards into the occipital lobe. It is very variable in its length and capacity.

The *descending horn* proceeds with a bold sweep round the hinder end of the optic thalamus, and then tunnels in a forward and inward direction through the temporal lobe towards the temporal pole.

Anterior Horn of the Lateral Ventricle.—The anterior horn forms the foremost part of the cavity, and extends

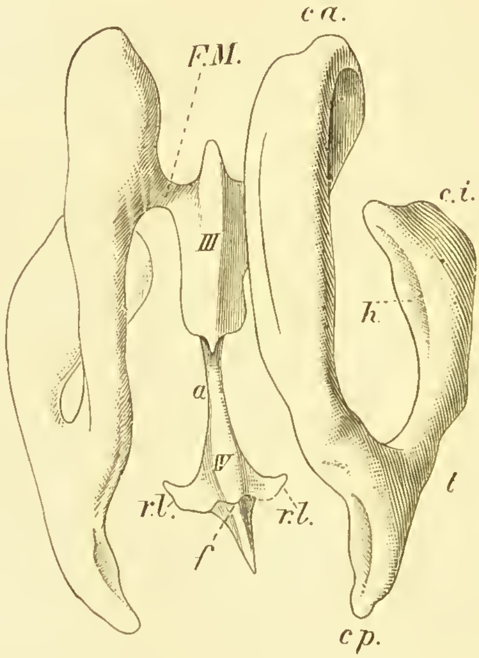


FIG. 293.—A drawing taken from a cast of the ventricular system of the brain. (From SCHWALBE, after WELCKER.)

III. Third ventricle.
IV Fourth ventricle.
F.M. Foramen of Monro.
a. Aqueduct of Sylvius.
r.l. Lateral recess of the fourth ventricle.
c.a. Anterior horn of lateral ventricle.
c.i. Descending horn.
c.p. Posterior horn.
h. Depression corresponding to prominence of hippocampus major.

in a forward and outward direction in the frontal lobe. When seen in coronal section it presents a triangular outline —the floor sloping upwards and outwards to meet the roof

at an acute angle (Fig. 294). It is bounded in front by the posterior surface of the genu of the corpus callosum, whilst the *roof* is formed by the fore part of the same structure. The *inner wall*, which is vertical, is formed by the septum lucidum — a thin mesial partition between the lateral ventricles of opposite sides. The sloping *floor* presents a marked elevation or bulging, viz., the smooth rounded and

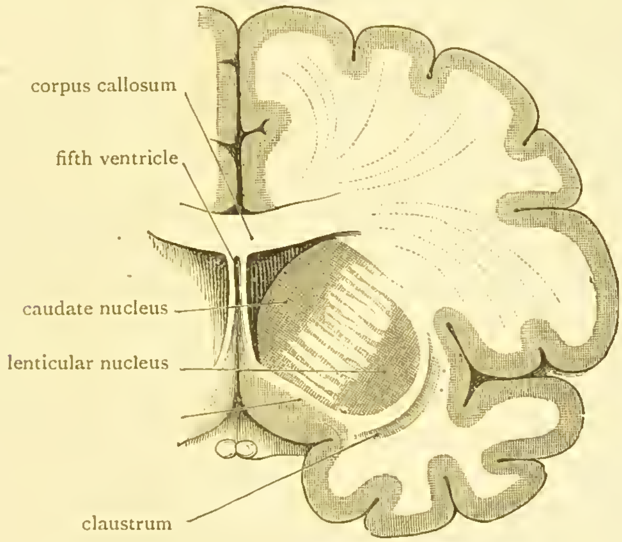


FIG. 294.—Coronal section through the right cerebral hemisphere and the anterior horn of the lateral ventricle. (GEGENBAUR.)

enlarged anterior extremity of the pear-shaped *caudate nucleus*.

The Body of the Lateral Ventricle is likewise roofed by the corpus callosum. On the *inner* or *mesial side* it is bounded by the hinder part of the septum lucidum, and behind this by the attachment of the fornix to the under surface of the corpus callosum. On the *outer side* it is closed, as in the case of the anterior horn, by the meeting of the roof and the floor of the cavity.

On the *floor* a number of important objects may be

recognised. From without inwards, and, at the same time, to some extent from before backwards, these are—(1) the caudate nucleus; (2) a groove which extends obliquely from before backwards and outwards between the caudate nucleus and the optic thalamus, and in which are placed the vein of the corpus striatum and a white band called the tænia semicircularis; (3) a portion of the upper surface of the optic thalamus; (4) the choroid plexus; (5) the thin sharp lateral edge of the fornix.

The *caudate nucleus* as it proceeds backwards on the outer part of the floor of the body of the lateral ventricle narrows very rapidly.

The *vein of the corpus striatum* is exposed in the groove between the caudate nucleus and the optic thalamus, if the ependyma which covers it be scraped away. It joins the vein of Galen at the foramen of Monro. In the same groove is placed the *tænia semicircularis*—a narrow band of white matter, which when traced forwards will be found to pass for the most part into the anterior pillar of the fornix.

The portion of the upper surface of the *optic thalamus*, which appears in the floor of the lateral ventricle, is in great part covered by the *choroid plexus* (plexus choroideus lateralis). The latter is a rich vascular fringe which appears from under cover of the sharp lateral edge of the fornix. In front, it is continuous, behind the foramina of Monro, with the corresponding choroid plexus of the opposite side, whilst behind it is carried into the descending horn of the ventricle. Although the choroid plexus has all the appearance of lying free within the ventricle, it must be borne in mind that it is invested by an epithelial layer which excludes it from the cavity, and which is connected on the one hand to the sharp margin of the fornix, and on the other to the upper surface of the optic thalamus.

Posterior Horn of the Lateral Ventricle.—The posterior horn is a diverticulum carried backwards into the occipital lobe from the hinder end of the body of the ventricle. It

tapers to a point and describes a gentle curve, the convexity of which is directed outwards. The *roof* and *outer wall* of this portion of the ventricular cavity is formed by the tapetum of the corpus callosum.

Upon the *inner wall* two elongated curved elevations may be observed. The uppermost of these is termed the *bulb of the cornu* (bulbus cornu posterioris) and is produced by the fibres of the forceps major as they curve abruptly backwards from the lower part of the splenium of the corpus callosum into the occipital lobe. Below this is the elevation known as the *hippocampus minor* or the *calcar avis*. It varies greatly in size in different brains, and is caused by an infolding of the ventricular wall in correspondence with the anterior calcarine fissure on the exterior of the hemisphere.

On the *floor* of the posterior horn, close to the hippocampus minor, a third elongated elevation may be visible. This is produced by a bundle of longitudinal fibres, termed the *fasciculus longitudinalis inferior*, which passes from the occipital into the temporal lobe.

Dissection.—The dissector should now gently insinuate his fingers underneath the fronto-parietal operculum of the insula and tear this portion of the cortex away in an upward direction. The frontal operculum (pars triangularis) and the orbital operculum should be dealt with in the same manner. The greater part of the temporal operculum has already been removed in opening up the descending horn of the ventricle. The insula or island of Reil is therefore fully exposed to view, and its relation to the parts in the interior of the ventricle can be seen.

Descending Horn of the Lateral Ventricle.—The descending horn must be regarded as the direct continuation of the main ventricular cavity, into the temporal lobe. The posterior horn is merely a diverticulum carried backwards from the main cavity. At first directed backwards and outwards, the posterior horn suddenly sinks downwards behind the optic thalamus into the temporal lobe, in which it takes a curved course forwards and inwards to a point about an inch behind the extremity of the temporal pole.

The *roof* of the descending horn is formed for the most part by the tapetum of the corpus callosum. At the extremity of the horn, the roof presents a slight bulging into the ventricular cavity. This is the *amygdaloid tubercle* and it is produced by a superjacent collection of grey matter, termed the *amygdaloid nucleus*. The *tænia semicircularis* and the greatly attenuated *tail of the caudate nucleus* are both prolonged into the descending horn, and are carried forwards in its roof to the amygdaloid nucleus in which they both end.

On the *floor* of the descending horn the dissector will observe the following parts: (1) the hippocampus major; (2) the choroid plexus; (3) the fimbria; (4) the trigonum ventriculi; and (5) the eminentia collateralis.

The Hippocampus Major (cornu ammonis) is for the most part covered by the choroid plexus. It is a prominent elevation on the floor of the descending horn of the lateral ventricle, and is strongly curved in conformity with the course taken by the horn in which it lies. It therefore presents an internal concave border, and an external convex margin. Narrow behind, it enlarges as it is traced forwards, and it ends below the amygdaloid tubercle in a thickened extremity which presents some faint grooves or notches on its surface. In consequence of this, the anterior end of the hippocampus major receives the name of the *pes hippocampi*. The hippocampus major is the internal elevation which corresponds to the dentate or hippocampal fissure on the exterior of the cerebrum.

The Fimbria (tænia hippocampi) is a narrow but very distinct band of white matter which is attached by its outer margin along the concave inner border of the hippocampus major. The white matter composing it is continuous with the thin white layer (alveus) which is spread over the surface of the hippocampus major, and it presents two free surfaces and a sharp free inner border. The fimbria has already been examined in connection with the hippocampal fissure and the gyrus dentatus, and the relations which it presents to

the posterior pillar of the fornix and the uncus have been pointed out (p. 526).

Inferior Fissure of the Cerebrum.—When the pia mater in the region of the hippocampal fissure is removed from the surface of the brain, the choroid plexus in the interior of the descending horn of the lateral ventricle is usually withdrawn with it, and a fissure appears between the fimbria and the roof of the ventricular horn. This is termed the *inferior fissure of the cerebrum* or the lower part of the *great transverse fissure.* By the withdrawal of the choroid plexus, it is converted into a gap which leads directly from the exterior of the brain into the interior of the descending horn of the lateral ventricle (Fig. 289).

The Choroid Plexus is a convoluted system of blood vessels in connection with a fold of pia mater which is prolonged into the descending horn of the lateral ventricle through the inferior fissure of the cerebrum. It lies on the surface of the hippocampus major, and is continuous behind the posterior border of the optic thalamus with the choroid plexus in the body of the lateral ventricle. But it must not be supposed that the choroid plexus lies free in the ventricular cavity. It is clothed in the most intimate manner by an epithelial layer, which represents the inner or mesial wall of the descending horn pushed into the cavity by the choroid plexus. The ventricle, therefore, only opens on the surface through the inferior cerebral fissure when this thin epithelial layer is torn away by the withdrawal of the choroid plexus.

The Trigonum Ventriculi (Fig. 295, *tr.v.*) is a smooth triangular surface on the floor of the ventricle at the junction of the posterior and descending horns. The hippocampus minor and the hippocampus major as they diverge from each other—the former curving backwards into the posterior horn and the latter curving forwards into the descending horn—bound the trigonum ventriculi in front and behind.

The Eminentia Collateralis is not always present. It may be recognised on the floor of the descending horn on the outer side of the hippocampus major as an elevation of

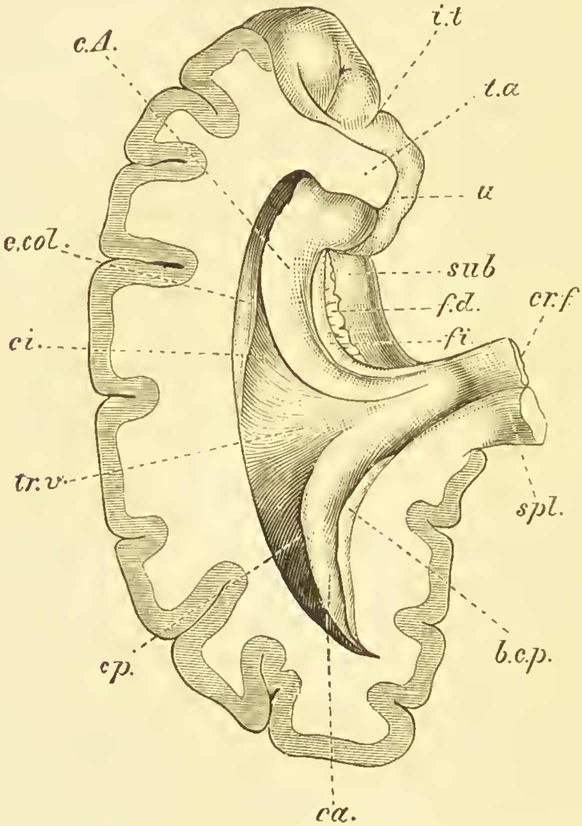


FIG. 295.—The detached occipital and temporal lobes of the cerebrum, with the descending and posterior horns of the lateral ventricle opened from above. (From SCHWALBE.)

cr.f. The posterior pillar of the fornix cut across.
spl. Splenium of the corpus callosum cut across.
fi. Fimbria.
f.d. Gyrus dentatus.
c.A. Hippocampus major.
sub. Hippocampal convolution.
u. Uncus.
t.a. Amygdaloid tubercle.
i.t. Incisura temporalis.
b.c.p. Bulbus cornu posterioris.
c.a. Hippocampus minor.
c.i. Descending horn.
c.p. Posterior horn.
tr.v. Trigonum ventriculi.
e.col. Eminentia collateralis.

very varying dimensions. It corresponds to the middle part of the collateral fissure on the inferior surface of the hemisphere.

Dissection.—The remains of the right temporal lobe and of the right occipital lobe should now be detached from the cerebrum by cutting through the fimbria where it passes into the posterior pillar of the fornix and the forceps major of the splenium of the corpus callosum. The knife should then be carried forwards from the anterior extremity of the descending horn above the level of the uncus through the temporal pole. The temporal lobe, with the hippocampal convolution along its inner side, can then be separated from the remainder of the brain, along the line of the inferior fissure of the cerebrum. In the detached part of the cerebrum (Fig. 295) a good view is obtained of the floor of the descending horn and of the parts in relation to it. Further, by replacing it in position, the inferior cerebral fissure can be better understood, and by turning the brain upside down a view of the roof of the descending horn and the structures in relation to it is gained. In this way the tail of the caudate nucleus and the tænia semicircularis can be traced into the amygdaloid nucleus.

The cut edge of the central part of the corpus callosum, which is still in position, should now be still further pared away, so as to bring more fully into view the subjacent septum lucidum and the fornix.

Septum Lucidum (septum pellucidum).—This is a thin vertical partition which intervenes between the anterior cornua and the fore parts of the bodies of the two lateral ventricles (Fig. 291). It is triangular in shape, and posteriorly it is prolonged backwards in the narrow interval between the body of the corpus callosum and the fornix, to both of which it is attached by its upper and lower edges. In front it occupies the gap behind the genu of the corpus callosum; whilst below, in the narrow interval between the rostrum of the corpus callosum and the fornix, it is prolonged downwards to the base of the brain as the *peduncle of the septum lucidum.*

The septum lucidum is composed of two thin laminæ in apposition with each other in the mesial plane. The mesial cleft between the layers is termed the *fifth ventricle* (Fig. 294).

Dissection.—The narrow middle strip of the corpus callosum, behind the bend of the genu, should now be removed. Cut it transversely

across behind the genu, and, gently raising it, separate the upper edge of the septum lucidum from its lower surface. Further back, behind the septum lucidum, it will be found to lie upon and to be anatomically connected with the upper surface of the fornix. This connection must also be severed. The left forceps major should be preserved, so that its connection with the occipital lobe may be more fully made out at a later stage. By snipping off the upper edge of the septum lucidum with the scissors, the two laminæ, with the interposed cleft or fifth ventricle will be exposed.

Fifth Ventricle.—This is the name which is applied to the mesial cleft between the two laminæ of the septum lucidum. It varies greatly in extent in different brains and contains a little fluid. It is completely isolated and presents no communication with the other ventricles or with the surface. Indeed, the term "ventricle" is somewhat inappropriate, because its developmental history shows that it has nothing in common with the general ventricular system of the brain. Each of its bounding laminæ consists of three thin strata, viz., an internal grey layer, an intermediate white layer, and a layer of ependyma, continuous with the lining ependyma of the lateral ventricle.

Fornix.—The fornix is an arched bilateral structure, composed of longitudinally directed fibres. In its intermediate part, its two lateral halves are joined together in the mesial plane, and form what is called the body of the fornix, but in front and behind they are quite separate, and constitute the anterior and posterior pillars of the fornix.

The *body of the fornix* is triangular in shape. In front, where it is continuous with the anterior pillars, it is narrow, whilst behind it broadens out, becomes flattened, and is prolonged into the posterior pillars. The upper surface of the body of the fornix is in contact with the under surface of the corpus callosum, and in the mesial plane is adherent to it and also to the posterior part of the lower edge of the septum lucidum. Its lateral edges are free, and extend outwards in the floor of the lateral ventricles. The lower surface of the body of the fornix rests upon the velum

interpositum, a fold of pia mater which separates it from the roof of the third ventricle and the upper surfaces of the two optic thalami.

The *anterior pillars of the fornix* (columnæ fornicis) are two rounded strands which emerge from the anterior part of the body of the fornix, and then diverge very slightly from each other as they curve downwards in front of the foramen of Monro. Sinking into the grey matter on the lateral wall of the third ventricle, each anterior horn proceeds downwards to the base of the brain, where it protrudes in the form of the corpus mammillare. This appears to be a twisted loop of the anterior pillar, in which the pillar turns upon itself, and is then continued upwards and backwards into the anterior tubercle of the optic thalamus. As there is good reason to believe that the fibres of the strand which ascends from the corpus mammillare are not directly continuous with those of the anterior pillar of the fornix, it receives the special name of the *bundle of Vicq d'Azyr.*

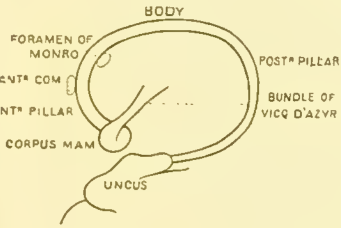


FIG. 296.—Diagram of the fornix ; profile view.

The connections which have just been described cannot be made out at present, but at a later period the dissector will experience little difficulty in tracing the anterior pillar of the fornix to the corpus mammillare, and in displaying the connection of this with the bundle of Vicq d'Azyr.

The *posterior pillars of the fornix* are flattened bands which diverge widely from the body of the fornix. At first they are adherent to the under surface of the corpus callosum, but soon they sweep downwards round the posterior ends of the optic thalami, and enter the posterior horns of the lateral ventricles. Here each posterior pillar comes into relation with the corresponding hippocampus major, and a portion of its fibres become spread out on the surface of

this prominence, forming the *alveus*, whilst the remainder constitute the fimbria or tænia hippocampi, which has already been described (pp. 526 and 538).

Dissection.—The body of the fornix should now be divided transversely across its middle. Its posterior and anterior portions may then be gently raised from the velum interpositum, and thrown forwards and backwards. Had it been possible to raise the corpus callosum and fornix together, the diverging posterior pillars of the latter would have been seen to limit a triangular space on the under surface of the corpus callosum in front of the posterior margin of the splenium. This interval is termed the *lyra*, and is traversed by a series of oblique and longitudinal markings. These markings indicate the presence of fibres, which pass across from one pillar of the fornix to the other, so as to form a white lamina. This lamina is not united to the under surface of the corpus callosum, and the interval between them is sometimes termed *Verga's ventricle.*

The Velum Interpositum is a double layer or fold of pia mater which intervenes between the body of the fornix, which is placed above it, and the roof of the third ventricle and the two optic thalami, which lie below it. Between the two layers are blood vessels and some subarachnoidal trabecular tissue. In shape the velum interpositum is triangular, and the narrow anterior end or apex reaches as far forwards as the foramina of Monro. The base lies under the splenium of the corpus callosum, and here the two layers of pia mater which form the velum become continuous with the investing pia mater on the surface of the brain.

Along each lateral margin the velum interpositum is bordered by the choroid plexus of the body of the lateral ventricle, which projects into the ventricular cavity from under cover of the lateral free edge of the fornix. Posteriorly this choroid plexus is continuous with the similar structure in the descending horn of the ventricle, whilst in front it narrows greatly and becomes continuous, across the mesial plane, with the corresponding plexus of the opposite side, behind the epithelium which lines the foramina of Monro. From this median junction two much smaller choroid plexuses run backwards on the under surface of the velum

interpositum, and project downwards into the third ventricle. These are the *choroid plexuses of the third ventricle* (Fig. 297).

The most conspicuous blood vessels in the velum interpositum are the two *veins of Galen*, which run backwards—one on either side of the mesial plane. In front, each is formed at the apex of the fold by the union of the vein of the corpus striatum with a large vein issuing from the choroid plexus ; behind, they unite to form the *vena magna*

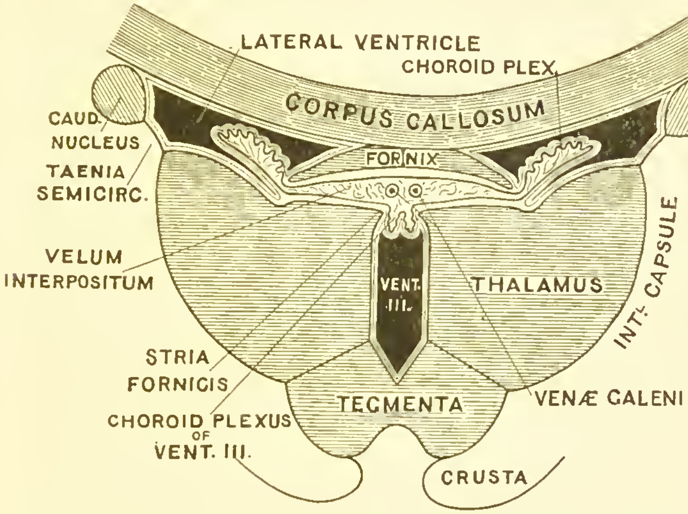


FIG. 297.—Diagrammatic coronal section through the optic thalami and the parts in immediate relation to them. The intermediate part of the great transverse fissure holding the velum interpositum is seen, and also the manner in which this fissure is shut out from the lateral ventricles by the epithelium which covers the choroid plexus on each side.

Galeni, and this pours its blood into the anterior end of the straight sinus (Fig. 191).

Great Transverse Fissure.—This name is given to the continuous cleft through which the velum interpositum and the choroid plexuses of the two descending horns of the lateral ventricles are introduced into the interior of the brain. It consists of an upper and intermediate part and two lateral

parts. The former passes forwards between the splenium of the corpus callosum and the body of the fornix above, and the roof of the third ventricle and the optic thalami below. It is limited by the epithelial covering of the choroid plexuses, which shuts out these structures from the cavity of the lateral ventricles.

The lateral part of the transverse fissure is termed the *inferior cerebral fissure* or the *choroidal fissure*. It is continuous with the intermediate part, and has already been studied in connection with the descending horn of the lateral ventricle (p. 539).

Dissection.—The vein of the corpus striatum should now be divided on each side as it passes into the vein of Galen. The apex of the velum interpositum should then be seized with the forceps, and the whole structure pulled backwards. The entire upper surface of the optic thalamus on each side is thus exposed, and between these bodies is seen the mesially placed third ventricle. The roof of this ventricle which is epithelial and invaginated into the cavity by the choroid plexuses on the under surface of the velum interpositum is torn away with that structure. The basal part of the velum interpositum is intimately connected with the pineal body which lies on the mesencephalon behind the third ventricle. Care therefore must be taken to extricate this body from the pia mater, otherwise it is sure to be pulled away.

Optic Thalamus.—The optic thalami are two large oval masses of grey matter, placed close together on either side of a deep mesial cleft which receives the name of the third ventricle of the brain. Each of these bodies presents an anterior and a posterior extremity, and an upper, lower, inner, and outer surface. The inferior and external surfaces are in apposition, and indeed, directly connected with adjacent parts, and on this account it is only possible to study them by means of sections through the brain. The superior and internal surfaces are free, and may be examined in the present dissection.

The *external* or *lateral surface* of the optic thalamus is applied to a mass of white matter, termed the *internal capsule*, which is largely composed of fibres derived from the *crusta*

or ventral part of the crus cerebri. The *inferior* or *ventral surface* of the thalamus rests chiefly upon the *subthalamic region* or the prolongation upwards of the dorsal tegmental part of the crus cerebri. The relation, therefore, which this

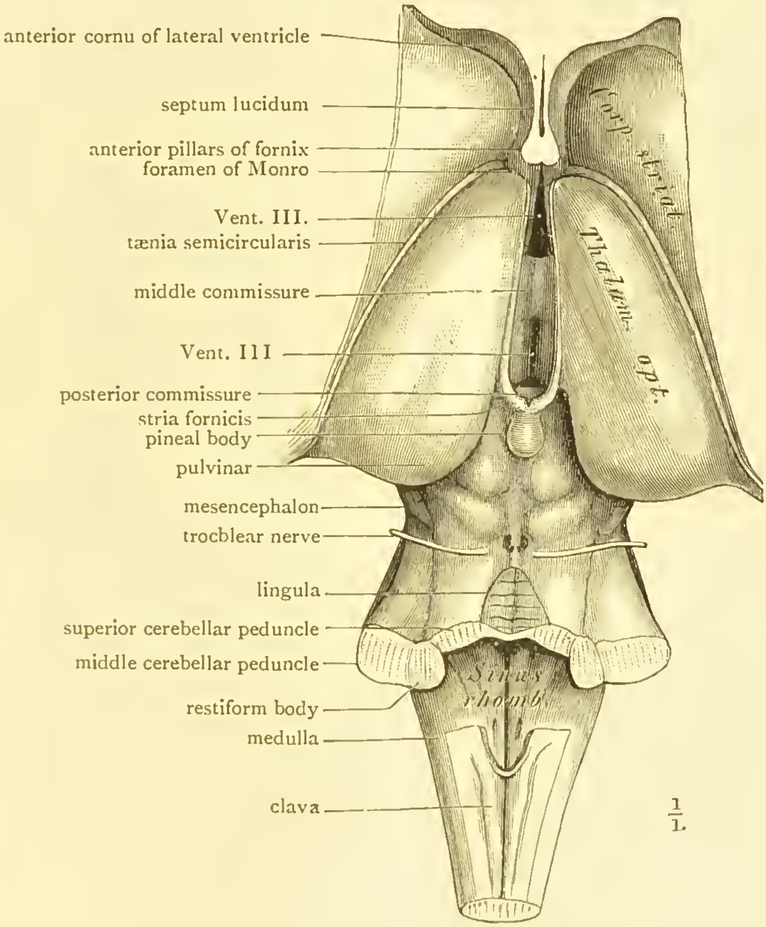


FIG. 298.—The medulla, mesencephalon, and thalamencephalon.

body presents to the upward continuation of the crus cerebri is very intimate.

The *superior* or *dorsal surface* of the thalamus is free. On the outer side it is bounded by the groove already

noticed on the floor of the lateral ventricle which intervenes between the thalamus and the caudate nucleus—a groove which contains the vein of the corpus striatum and the tænia semicircularis. On the inner side the superior surface of the thalamus is separated in its anterior half from the internal or mesial surface by a sharp edge, or rather by a somewhat prominent ledge, produced by a small white strand, termed the *stria fornicis* or the *stria pinealis*. Posteriorly, this stria leads to the pineal body, whilst anteriorly it runs into the anterior pillar of the fornix.

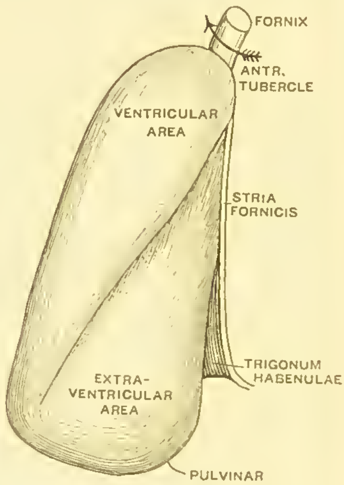


FIG. 299.—Upper surface of the left thalamus.

The superior surface of the thalamus is slightly bulging or convex, and is of a whitish colour owing to the presence of a thin superficial coating of nerve fibres (stratum zonale). It is divided into two areas by a faint oblique groove which begins in front a short distance behind the anterior extremity of the thalamus, and extends obliquely outwards and backwards. This sulcus corresponds to the free edge of the fornix. The two areas thus mapped out are very differently related to the ventricles of the brain. The *outer area* includes the anterior extremity of the thalamus, and forms a part of the floor of the lateral ventricle; it is covered with ependyma, and overlapped by the choroid plexus (Fig. 297). The *inner area* intervenes between the lateral and third ventricles of the brain, and takes no part in the formation of the walls of either. It is covered by the velum interpositum, above which is the fornix. It includes the posterior extremity of the thalamus.

The *anterior extremity* of the thalamus, called the *anterior tubercle* (tuberculum anterius), is rounded and prominent. It projects into the lateral ventricle, lies behind and to the outer side of the free portion of the anterior pillar of the fornix, and bounds the foramen of Monro behind.

The *posterior extremity* of the thalamus is very prominent, and projects backwards so as to overhang a portion of the mesencephalon (viz., the brachia of the quadrigeminal bodies) (Fig. 298). This projecting part is called the *pulvinar*. But the hinder end of the thalamus shows another prominence. This is situated below and behind the pulvinar. It is oval in form, and receives the name of the *corpus geniculatum externum*.

The *mesial surfaces* of the two thalami are covered with the lining ependyma of the third ventricle, and are placed very close together. Indeed, at one spot they are actually joined by a band of grey matter which forms the *grey* or *soft commissure* of the brain (commissura mollis).

Trigonum Habenulæ.—This term is applied to a small, depressed, triangular area which occupies the interval between the pulvinar and the peduncle of the pineal body.

The Pineal Body (conarium or epiphysis cerebri) is a little structure of a darkish colour, and about the size of a cherry stone, which is placed between the hinder extremities of the two thalami on the dorsal aspect of the mesencephalon (Fig. 298). It occupies the groove between the two superior quadrigeminal bodies, and is shaped like a fir-cone. Its base, which is directed upwards, is attached by means of a hollow stalk or peduncle. This stalk is separated into a dorsal and a ventral part by a continuation backwards into it of a pointed recess of the cavity of the third ventricle. The dorsal part of the stalk is carried forwards on each optic thalamus as the tænia fornicis; the ventral part is folded round a narrow but conspicuous cord-like band of white fibres, which crosses the mesial plane immediately above

the base of the pineal body, and receives the name of the *posterior commissure* of the cerebrum.

Anterior Commissure of the Cerebrum.—In the anterior part of the cleft between the two optic thalami, and immediately in front of the anterior pillars of the fornix, a round bundle of white fibres will be seen crossing the mesial plane. This is the anterior commissure. It is very much larger than the posterior commissure, and will be afterwards followed towards the temporal lobe in which the greater part of it ends.

Third Ventricle.—This name is given to the deep narrow cleft between the two optic thalami. Broadly speaking, it may be said to extend from the posterior commissure behind to the anterior commissure in front. Its *floor* is formed by the parts already studied within the interpeduncular space on the base of the brain, viz., the tuber cinereum, the corpora mammillaria, and the grey matter of the locus perforatus posticus, and also to some extent behind these by the tegmenta of the crura cerebri. *In front* it is bounded by the lamina cinerea and the anterior commissure; whilst its *lateral walls* are formed by the mesial surfaces of the two optic thalami. A little in front of the middle of the ventricle the cavity is crossed by the *middle or soft commissure*, which connects the thalami with each other, and in front of this the anterior pillar of the fornix is seen descending in the lateral wall. At first this is distinct and prominent, but it gradually becomes more and more sunk in the grey matter on the side of the ventricle as it approaches the corresponding corpus mammillare.

The *roof* of the third ventricle is formed by a thin epithelial layer, continuous with the epithelial lining of the cavity, which stretches across the mesial plane from the one tænia fornicis to the other. It is applied to the under surface of the velum interpositum which overlies the ventricle, and is invaginated into the cavity by the choroid plexuses which hang down from the under surface of this

fold of pia mater. In the removal of the velum interpositum this thin epithelial roof has been torn away.

The third ventricle communicates freely with the lateral ventricles, and also with the fourth ventricle. The *aqueduct of Sylvius*, a narrow channel which tunnels the mesencephalon, brings it into communication with the fourth ventricle. The opening of this aqueduct will be seen at the posterior part of the floor of the ventricle, immediately below the posterior commissure. The *foramina of Monro* bring it into communication with the two lateral ventricles. The latter apertures are placed at the upper and fore parts of the lateral walls, and lead outwards and slightly upwards between

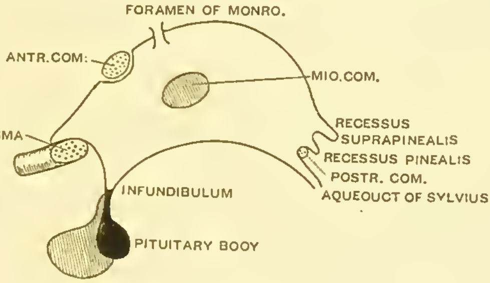


FIG. 300.—Diagrammatic outline of the third ventricle as viewed from the side.

the most prominent parts of the anterior pillars of the fornix, and the anterior tubercles of the optic thalami. They are just large enough to admit a crowquill, and through these passages the epithelial lining of the three ventricles becomes continuous.

The outline of the third ventricle when viewed from the side in a mesial section through the brain (Fig. 300), or as it is exhibited in a plaster cast of the ventricular system of the brain, is seen to be very irregular. It presents several diverticula or recesses. Thus, in the fore part of the floor there is a deep funnel-shaped pit or recess leading down through the tuber cinereum into the infundibulum of the pituitary body. Another recess leads forwards immediately in front of this, above the optic chiasma. Posteriorly two additional recesses are present. One,

the *recessus pinealis*, passes backwards, above the posterior commissure and the entrance of the aqueduct of Sylvius, for a short distance into the stalk of the pineal body. The second is placed above this and is carried backwards for a greater distance. Its walls are epithelial, and therefore it cannot be seen in an ordinary dissection. It is termed the *recessus suprapinealis.*

Dissection.—The further study of the cerebrum should be postponed until after the examination of the mid-brain or mesencephalon. The membranes should be removed from the upper surface of the cerebellum, and the prominent anterior part of this organ may then be gently pulled backwards to expose as far as possible the corpora quadrigemina, *i.e.*, the four rounded eminences on the dorsal aspect of the mesencephalon. In doing this, care should be taken to secure and preserve the slender trochlear nerve which winds forwards round the outer side of the crus cerebri, and which issues from a lamina called the valve of Vieussens, immediately below the inferior pair of quadrigeminal bodies.

THE MESENCEPHALON.

Mesencephalon.—The mesencephalon or isthmus encephali is the stalk which occupies the opening of the tentorium cerebelli, and connects the cerebrum with the parts in the posterior cranial fossa. It is about three-quarters of an inch long, and it consists of a dorsal part composed of the corpora quadrigemina, and a much larger ventral part which is formed by the two large crura cerebri. In the undissected brain the corpora quadrigemina are completely hidden from view by the splenium of the corpus callosum, which projects backwards over them, and also by the superimposed cerebral hemispheres. The crura cerebri, however, can to some extent be seen on the base of the brain, where they bound the posterior part of the interpeduncular space. The mesencephalon is tunnelled from below upwards by a narrow passage called the aqueduct of Sylvius. This channel lies much nearer its dorsal than its ventral surface.

Corpora Quadrigemina (optic lobes).—The four rounded eminences on the dorsal aspect of the mesencephalon to

which this name is applied are for the most part composed of grey matter, although each has a superficial coating of white fibres. The *superior pair* are larger and broader than the *inferior pair*, but they are not so well defined nor yet so prominent.

A longitudinal and a transverse groove separate the quadrigeminal bodies from each other. The *longitudinal groove* occupies the mesial plane, and extends upwards as far as the posterior commissure. From its lower end a short but well defined narrow band of white fibres, the *frænulum veli*, passes to the valve of Vieussens—a lamina placed immediately below the inferior pair of quadrigeminal prominences. The upper part of the longitudinal groove is occupied by the pineal body. The *transverse groove* curves round behind each of the superior pair of quadrigeminal bodies, and separates them from the inferior pair.

Brachia of the Corpora Quadrigemina.—The corpora quadrigemina are not marked off from the side of the mesencephalon, but each body has in connection with it on this aspect a prominent white strand, which is prolonged upwards and forwards under the projecting pulvinar and corpus geniculatum externum on the hinder end of the optic thalamus. These strands are called the *brachia* of the corpora quadrigemina, and they are separated from each other by a continuation on the side of the mesencephalon of the transverse groove which intervenes between the two pairs of bodies.

Corpus Geniculatum Internum.—Closely connected with the brachia of the corpora quadrigemina will be seen the corpus geniculatum internum. It is a little oval eminence, very sharply defined, which lies on the side of the upper part of the mesencephalon under shelter of the pulvinar of the optic thalamus.

Connections of the Brachia and the Origin of the Optic Tract.—It will now be seen that the brachia are intimately connected with the optic tract. The *inferior brachium* pro-

ceeding upwards from the lower quadrigeminal body advances towards the corpus geniculatum internum, and disappears from view under cover of this prominence. Upon the opposite side of this same geniculate body, the *mesial root* of origin of the *optic tract* is observed to arise, and the appearance is such that the dissector might very naturally conclude that the inferior brachium and this root of the optic tract are continuous. It is very doubtful, however, if this is the case. The *superior brachium* is carried upwards and forwards between the overhanging pulvinar and the corpus geniculatum internum. It partly enters the corpus geniculatum externum, but a portion of it can easily be observed to be directly continuous with the *lateral root* of the optic tract.

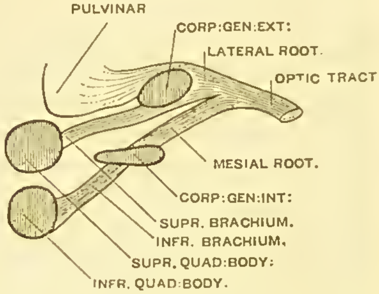


FIG. 301.—Diagram of the roots of the optic tract.

The optic tract, therefore, arises by two roots—a mesial and a lateral. The *mesial root* emerges from under the inner geniculate body. The *lateral root* is continuous with the superior brachium, and through it with the superior quadrigeminal body. It also is closely connected with, and derives fibres from, the corpus geniculatum externum and the pulvinar. The optic tract thus formed curves round the outer side of the upper part of the crus cerebri to reach the optic chiasma.

Crura Cerebri.—The crura cerebri constitute the chief bulk of the mesencephalon. When viewed from below, they appear as two large rope-like strands, which emerge close together from the upper aspect of the pons Varolii, and diverge as they proceed upwards to enter the cerebrum. At the point where each crus disappears into the corresponding side of the hemisphere, it is embraced on its outer side by the optic tract.

The crus cerebri of each side consists of two parts, viz., a dorsal *tegmentum*, which is prolonged upwards to the region

below the thalamus; and a ventral *crusta* or *pes* which is carried upwards into the internal capsule on the outer side of the thalamus. When the base of the brain is examined, it is the crusta which is seen, and it is observed to be white in colour and streaked in the longitudinal direction. On the exterior of the mesencephalon, the separation between the two parts of the crus cerebri (*i.e.*, the tegmentum and the crusta) is indicated by an inner and an outer groove or sulcus. The inner or mesial sulcus is the deepest and most distinct. It looks into the interpeduncular space, and from it emerge the fascicles of the oculomotor nerve. It consequently receives the name of the *sulcus oculomotorius.* The outer sulcus is termed the *sulcus lateralis.*

Dissection.—The mesencephalon should now be divided transversely by one sweep of the knife at the level of the lower borders of the superior pair of corpora quadrigemina. By this proceeding, the cerebrum is separated from the parts below. A number of very important points can be made out on the cut surface of the mesencephalon.

Cut Surface of the Mesencephalon (Fig. 302).—Much nearer the dorsal than the ventral surface of the mesencephalon the transversely divided *aqueduct of Sylvius* may be seen. As already stated, this narrow passage leads from the fourth ventricle below, upwards through the mesencephalon to the third ventricle above. It is surrounded by a thick layer of grey matter, called the *Sylvian grey matter*, or the *central grey matter of the aqueduct.* In a fresh brain this is always very conspicuous, and in its midst are situated the nuclei of the oculomotor and trochlear nerves, and the upper nucleus of the trigeminal nerve, although of course these cannot be detected by the naked eye. Below, this grey matter of the aqueduct is continuous with the grey matter spread out on the floor of the fourth ventricle, whilst above, it is continuous with the grey matter on the floor and sides of the third ventricle.

The division between the tegmentum and the crusta is rendered very evident by a conspicuous mass of dark

pigmented matter which intervenes between them. This is termed the *substantia nigra.*

Substantia Nigra.—As seen in transverse section the substantia nigra presents a somewhat crescentic outline, and is largely composed of pigmented nerve cells. It is in reality a thick band which begins below at the upper border of the pons Varolii, and extends upwards in the midst of the crus cerebri, as high as the corpora mammillaria. The margins of this band of dark coloured substance come to the surface at the oculomotor and lateral sulci, and its inner part is traversed by the emerging nerve fibres of the oculomotor

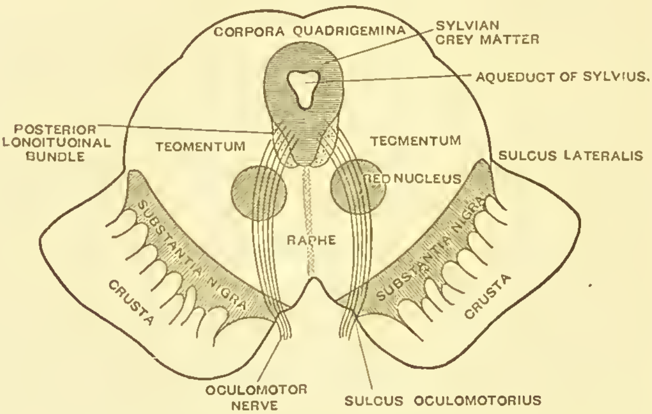


FIG. 302.—Diagrammatic view of the cut surface of the mesencephalon when transversely divided.

nerve. The surface turned towards the tegmentum is concave and uniform; the opposite surface is convex, and rendered highly irregular by the presence of numerous slender prolongations of the substance into the crusta.

The Crusta.—The crusta is somewhat crescentic when seen in section, and stands quite apart from its fellow of the opposite side. It is composed of a compact mass of longitudinally directed nerve fibres which are carried upwards into the internal capsule. The middle third of each crusta is composed of the important *pyramidal tract*, but this is

quite indistinguishable from the portions of the crusta which lie on either side of it.

The Tegmentum.—Unlike the crustæ, the tegmenta are directly continuous with each other in the mesial plane, a faint line, termed the median raphe, alone indicating their bilateral character. Towards the dorsum of the mesencephalon they are also fused with the bases of the corpora quadrigemina. Their lateral surfaces therefore are alone free.

The tegmentum is composed of an admixture of grey and white matter, constituting what is termed the *formatio reticularis*. The white matter is composed of fibres running both transversely and longitudinally. Certain of the longitudinal fibres are grouped together and form well marked tracts, which, in a section through the mesencephalon of a fresh brain, can be detected by the naked eye. These tracts are: (1) the posterior longitudinal bundles; (2) the superior cerebellar peduncles or the brachia conjunctiva; (3) the fillet.

The *posterior longitudinal bundle* (Fig. 302) is a small compact tract which is placed upon the outer aspect of the lower portion of the central grey matter of the aqueduct.

The *superior cerebellar peduncles* are two large strands which are continued upwards from the cerebellum into the cerebrum. By pulling back the margin of the cerebellum where it overlaps the lower quadrigeminal bodies, these peduncles will be seen on the surface as they converge in an upward direction. Stretching across the interval between them, and bringing them into continuity with each other, is a thin lamina called the valve of Vieussens. When the peduncles under consideration reach the bases of the inferior quadrigeminal bodies, they sink into the substance of the mesencephalon, and in a transverse section through the lower part of this portion of the brain they may be seen as two white strands, semilunar in outline, and placed one on either side of the grey matter of the aqueduct. As they ascend, they gradually assume a deeper (*i.e.*, a more ventral) position in the tegmental part of the mesencephalon, and finally they decussate with each other across the mesial plane and proceed upwards to the cerebrum.

The *fillet* is a very complicated tract, and very little can be learnt of its connections in the course of an ordinary dissection. One part of it, however, termed the *lower* or *lateral fillet*, can be readily detected on the outer free surface of the lower part of the tegmentum in the form of some curved and usually conspicuous fibres which extend upwards and backwards to reach the inferior quadrigeminal body and its brachium.

Within the tegmentum there is a collection of nuclear matter which is termed the *red tegmental nucleus* from its ruddy appearance when seen in section. It is rod-like in form, and extends upwards into the tegmental region below the optic thalamus. In transverse section it presents a circular outline, and it is closely associated with the upward prolongation of the fibres of the superior cerebellar peduncle.

BASAL GANGLIA OF THE CEREBRAL HEMISPHERES.

The basal ganglia of the cerebrum still require to be examined. These are the caudate and lenticular nuclei, which together form the corpus striatum, the claustrum, and the amygdaloid nucleus. With these it is necessary also to study the composition of the optic thalamus and the external and internal capsules.

Dissection.—The right and left portions of what remains of the cerebrum should be separated from each other by a mesial incision. On the left portion the sulci, and convolutions on the under or tentorial surface of the hemisphere, may be examined if this has not been done already on another specimen.

A series of sections should, in the next place, be made through both the right and left portions of the cerebrum, with the view of displaying the basal ganglia. On *the right side* remove a succession of thin slices by carrying a long knife in a horizontal direction through the parts which form and lie below the floor of the body of the lateral ventricle. It is not advisable to proceed further than the level of the anterior commissure.

On *the left side* of the brain a series of vertical-transverse or coronal sections should be made through the remaining portion of the cerebrum. Begin by cutting off the portion in front of the head of the caudate nucleus, and then proceed steadily backwards until the hinder part of the optic thalamus is reached. One of the sections should be planned to pass through the anterior commissure.

The Caudate Nucleus has already been partly examined in connection with the lateral ventricle, into the cavity of which it bulges. It is a pyriform highly arched mass of grey matter, which presents a thick swollen head or anterior

extremity, and a long attenuated tail. The head projects into the anterior horn of the lateral ventricle, whilst its

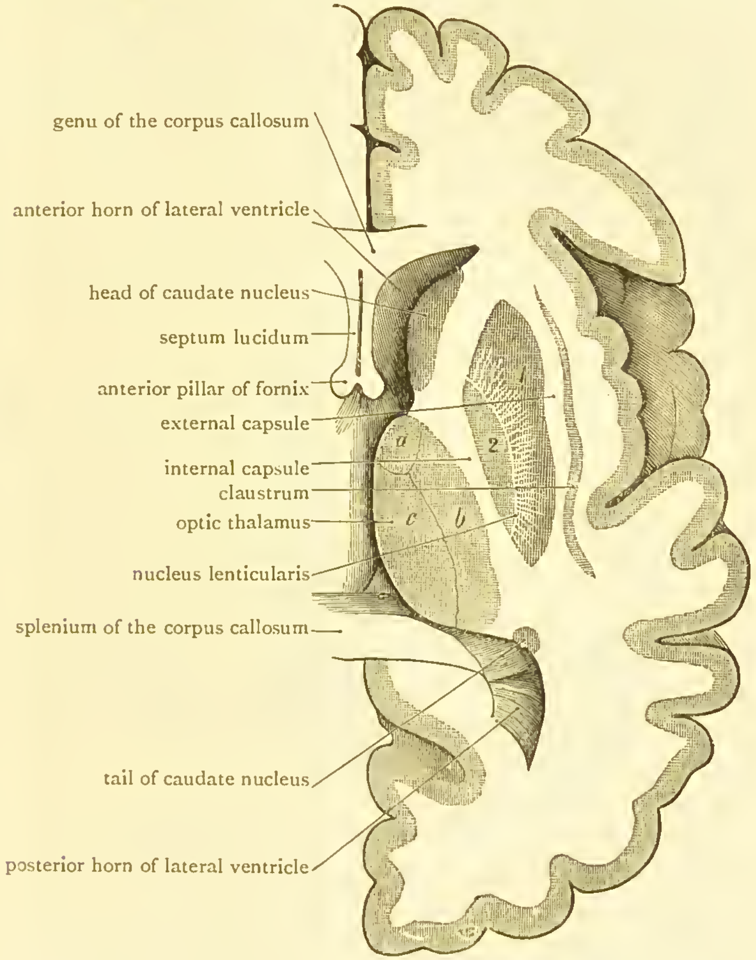


FIG. 303.—Horizontal section through right side of the cerebrum—a little above the level of the anterior commissure. (From GEGENBAUR.)

a, *b*, *c*. The three nuclei of the optic thalamus.
1. Putamen.
2. Globus pallidus.

narrower part is prolonged outwards and backwards on the floor of the body of the ventricle, where it is separated from

the optic thalamus by the tænia semicircularis. Finally, its tail turns downwards and then forwards into the descending horn of the lateral ventricle, on the roof of which it is prolonged until it finally joins the amygdaloid nucleus. The caudate nucleus, therefore, presents a free ventricular surface covered with ependyma, and a deep surface embedded in the substance of the cerebrum, and for the most part related to the internal capsule.

Owing to its arched form, it follows that in horizontal sections below a particular level it is cut at two points, and both the head and the tail must be looked for in the field of section (Fig. 303).

The Lenticular Nucleus lies on the outer side of the caudate nucleus and the optic thalamus, and is for the most part completely embedded within the white medullary substance of the cerebral hemisphere. It does not occupy so much ground as the nucleus caudatus. Indeed, it presents a very close correspondence in point of extent with the island of Reil on the surface.

When seen in horizontal section (Fig. 303) it presents a shape similar to that of a biconvex lens. Its inner surface bulges more than the outer surface, and its point of highest convexity is placed opposite the tænia semicircularis or the interval between the caudate nucleus and the anterior end of the optic thalamus.

When seen in coronal section, the appearance presented by the lenticular nucleus differs very much in the different planes of section. Figure 304 represents a section through its anterior portion. Here it is semilunar or crescentic in outline. Further, it is intimately connected with the head of the caudate nucleus by bands of grey matter which pass between the two nuclei and break up the fore part of the internal capsule. It is due to the ribbed or barred appearance which is presented by such a section as this that the term *corpus striatum* is given to the two nuclei.

When the section is made in a plane further back, the

divided lenticular nucleus assumes an altogether different shape, and is seen to be completely cut off from the caudate nucleus by the internal capsule (Fig. 305). It is now triangular or wedge-shaped. Its base is turned towards the external capsule, the claustrum, and the island of Reil; its internal surface is applied to the internal capsule; whilst its inferior surface is directed downwards towards the base of the brain. But, further, two white laminæ are now evident, the *external* and the *internal medullary laminæ*, which traverse its substance and divide it

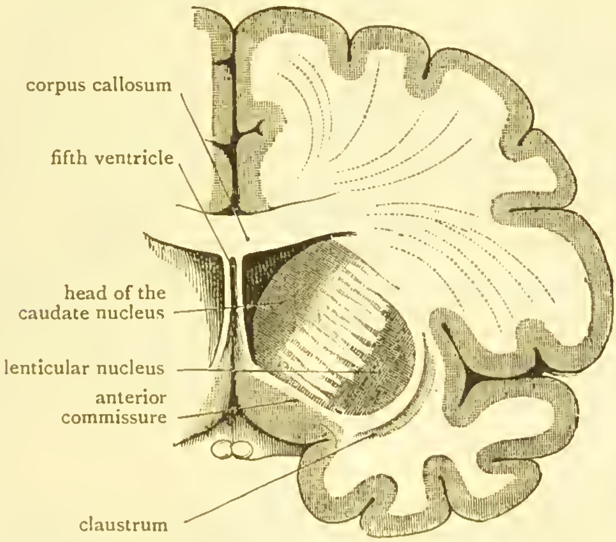


FIG. 304.—Coronal section through the anterior part of the corpus striatum. (From GEGENBAUR.)

into three zones. The outer, basal, and larger zone, is termed the *putamen* (Fig. 305, 1). It is darker in colour than the other two zones, and is traversed by fine radiating white streaks. The two inner zones are of a faint yellowish tint, and they together form what is termed the *globus pallidus* (Fig. 305, 2 and 3). The putamen has a greater antero-posterior length than the globus pallidus. It follows from this that it alone is connected with the head of the caudate nucleus by the intervening bands of grey matter (Fig. 304).

The nucleus lenticularis comes to the surface at the anterior perforated spot, and a continuity between the grey matter forming it and the grey cortex of the brain is thus established.

The Claustrum is a thin plate of grey substance embedded in the white matter which intervenes between the lenticular nucleus and the grey cortex of the island of Reil.

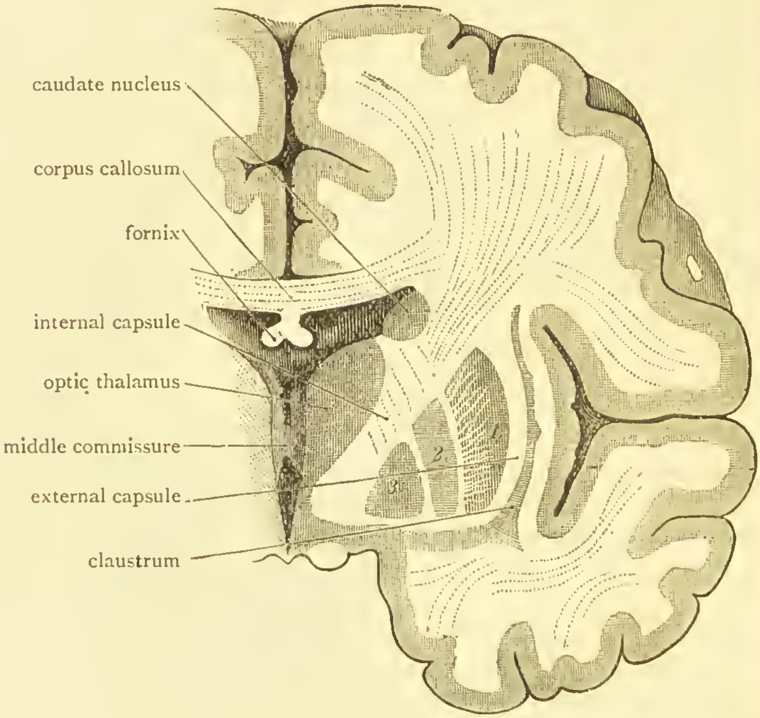


FIG. 305.—Coronal section through the corpus striatum in a plane posterior to the section exhibited in Figure 304.

1. Putamen. 2, 3. Two zones of the globus pallidus.

Followed in an upward direction it becomes gradually thinner until it ultimately appears, when seen in section, as an exceedingly delicate grey streak. As it is traced downwards, however, it thickens considerably, and at the base of the brain it comes to the surface at the anterior perforated spot, and becomes continuous with the grey matter of the

cerebral cortex. Its extent corresponds very nearly with the area occupied by the island of Reil, and its surface towards this portion of the cerebral cortex shows ridges and depressions corresponding to the insular gyri and sulci.

Internal Capsule.—This term is applied to the broad band of white matter which intervenes between the lenticular nucleus on the outside, and the optic thalamus, tænia semicircularis, and caudate nucleus on the inner side. In front it is much broken up by the connecting bands of grey matter which pass between the head of the caudate nucleus

cau. Caudate nucleus.
n.l. Lenticular nucleus.
t.o. Optic tract.
pc. Crusta of the cerebral peduncle.
s.n. Substantia nigra.
v.III. Third ventricle.
co.m. Middle commissure.
d. Subthalamic body.
b. Zona incerta.
c. Dorsal layer of the subthalamic region.
f. Bundle of Vicq d'Azyr.
i.k. Inner nucleus } of the optic thalamus.
a.k. Outer nucleus } of the optic thalamus.
v.k. Anterior nucleus } of the optic thalamus.
st.t. Tænia semicircularis.
c.i. Internal capsule.

FIG. 306.—Coronal section through the optic thalamus and the corpus striatum opposite the middle commissure.

and the fore part of the putamen of the lenticular nucleus (Fig. 304); but behind this it forms a solid white mass of nerve fibres. When seen in horizontal section, the internal capsule is observed to be bent upon itself opposite the tænia semicircularis, or the interval between the caudate nucleus and the thalamus (Fig. 303). This bend, which points inwards, is called the *genu.* About one-third of the internal capsule lies in front of the genu, and this part is called the *anterior limb;* the remaining two-thirds, which lie behind the genu, constitute the *posterior limb.*

Connections of the Internal Capsule.—The internal capsule is directly continuous below with the crusta of the cerebral peduncle (Fig. 306). The dissector can easily satisfy himself in the specimens before him of this continuity, but it is more especially apparent in the more posterior of the coronal sections which he has made through the left portion of the cerebrum.

It has already been mentioned that the fibres which occupy the middle third of the crusta of the cerebral peduncle belong to the motor pyramidal tract. In the internal capsule these occupy the anterior half of the posterior limb, being thus placed immediately behind the genu. The fibres which constitute the inner third of the crusta are carried upwards into the anterior limb of the internal capsule; whilst the fibres which form the outer third of the crusta enter the posterior half of the posterior limb.

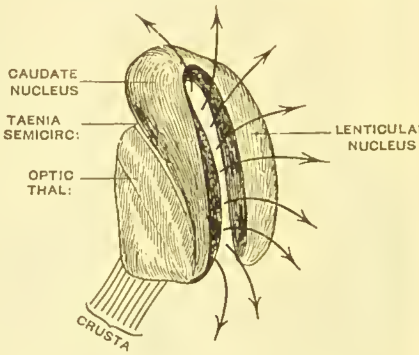


FIG. 307.—Diagrammatic representation of the radiation of the fibres of the internal capsule. (After TESTUT, modified.)

When the fibres of the internal capsule are traced upwards, they are found to spread out in a radiating or fan-like manner so as to reach the various convolutions of the cerebral hemispheres. This arrangement is termed the *corona radiata*. Now, it has been observed that the internal capsule may be, broadly speaking, divided into thirds, each of which corresponds with a portion of the crusta. The fibres of the anterior third, or, in other words, of the anterior limb of the internal capsule, pass upwards into the prefrontal region of the cerebral hemisphere; those of the middle third (the pyramidal fibres) go to the convolutions of the Rolandic or motor area of the hemisphere; whilst those of the posterior third proceed into the occipital and temporal lobes.

Nuclei of the Optic Thalamus.—When a horizontal section is made through the optic thalamus in a fresh brain, or in one which has been preserved by means of a chromic salt, the grey matter composing it is seen to be broken up

into an external, internal, and an anterior nucleus (Figs. 308) by thin internal medullary laminæ.

External Capsule.—This term is applied to the narrow band of white matter which intervenes between the lenticular nucleus and the claustrum (Figs. 303, 304, and 305).

Dissection.—The bundle of Vicq D'Azyr and the anterior commissure should now be followed as far as this is possible in what remains of the right half of the cerebrum. In neither case is the dissection a difficult one.

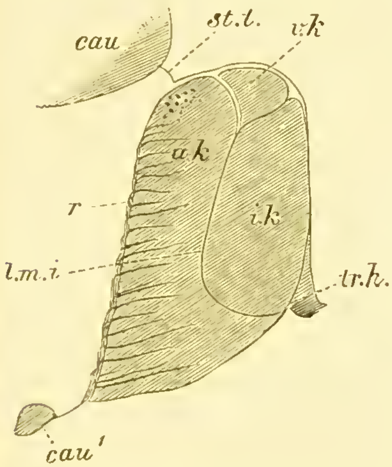


FIG. 308.—Horizontal section through the left optic thalamus. (SCHWALBE.)

cau & *cau* 1. Head and tail of the caudate nucleus.
v.k. Anterior nucleus, *i.k.* Inner nucleus, *a.k.* Outer nucleus } of the thalamus.
st.t. Tænia semicircularis.
l.m.i. Internal medullary lamina.
r. External medullary lamina.
tr.h. Trigonum habenulæ.

By removing the remains of the lenticular nucleus the anterior commissure will be exposed in its course towards the temporal lobe. In the first instance, it passes transversely outwards through the lower part of the globus pallidus and below the putamen. It then bends suddenly backwards to reach the medullary centre of the temporal lobe, above the descending horn of the lateral ventricle. If the dissection be successfully accomplished, the anterior commissure will be seen to present a twisted or rope-like appearance.

The *bundle of Vicq d'Azyr* may be traced from the corpus mammillare upwards into the anterior nucleus of the optic thalamus by scraping away the grey matter on the side of the third ventricle. The continuity between the anterior pillar of the fornix and the corpus mammillare should at the same time be established. Within the corpus mammillare there is a small nucleus of grey matter.

THE PARTS OF THE BRAIN WHICH LIE IN THE POSTERIOR CRANIAL FOSSA.

The parts which lie below the tentorium cerebelli in the posterior cranial fossa are the *medulla oblongata*, the *pons Varolii*, and the *cerebellum*. These are grouped around the *fourth ventricle* of the brain—a cavity which communicates below with the central canal of the spinal cord, and above with the aqueduct of Sylvius. Through the latter it establishes a connection with the third ventricle of the brain.

Medulla Oblongata.—This is the continuation of the spinal cord into the brain. It is not more than one inch in length, and may be reckoned as beginning at the level of the foramen magnum. From this it proceeds upwards in a very nearly vertical direction, and ends at the lower border of the pons Varolii. At first its girth is similar to that of the cord, but it rapidly expands as it approaches the pons, and consequently it presents a more or less conical appearance. Its anterior surface lies behind the groove on the basilar portion of the occipital bone, whilst its posterior aspect is sunk into the vallecula of the cerebellum.

The medulla oblongata is a bilateral structure, and this is evident even by an inspection of its exterior. The antero-median and postero-median grooves on the surface of the spinal cord are prolonged upwards on the anterior and posterior faces of the medulla.

The *antero-median groove*, as it passes from the cord on to the medulla, is interrupted at the level of the foramen magnum by several strands of fibres which cross the mesial plane from one side to the other. This inter-crossing is termed the *decussation of the pyramids*. Above this level the furrow is carried upwards without interruption to the lower border of the pons. Here it expands slightly, and ends in a blind pit, termed the *foramen cæcum* of Vicq d'Azyr.

The *postero-median fissure* is only carried up for half the length of the medulla. At this point the central canal of

the cord opens on the dorsal aspect of the medulla, and the lips of the postero-median fissure are thrust widely apart from each other, so as to constitute the limits of a triangular area, which forms on the posterior surface of the medulla, the lower part of the *fossa rhomboidalis*, or the floor of the fourth ventricle. The dissector is now in a position to understand the terms "closed" and "open" as applied to different portions of the medulla. The lower half of the medulla, containing as it does the central canal in its interior, is the *closed part;* the upper half, above the opening of the central canal, which by its dorsal surface forms the lower part of the floor of the fourth ventricle, is the *open part* of the medulla.

The surface of each lateral half of the medulla should now be studied. It is well, however, to defer for a little the examination of the medullary part of the floor of the fourth ventricle. The dissector has already noticed two linear rows of nerve fascicles issuing from and entering the medulla on each side. The *anterior row* consists of the roots of the hypoglossal and the uppermost part of the anterior root of the first cervical nerve. They continue upwards on the medulla, the line of the anterior nerve roots of the spina cord, and they emerge along the bottom of a more or less distinct groove. The *posterior row* is formed of the nerve fascicles of the spinal accessory, vagus and glosso-pharyngeal nerves, and they lie in series with the posterior roots of the spinal nerves.

By these two rows of nerve fascicles, each side of the medulla is divided into three districts, viz., an anterior, a lateral, and a posterior, similar to the surface areas of the three columns on the side of the cord. At first sight, indeed, they appear to be a direct continuation upwards of these portions of the cord; it is easily demonstrated, however, that this is not the case, and that the fibres in the three columns of the cord undergo a rearrangement as they are traced into the medulla.

Anterior Area of the Medulla—Anterior Pyramid.—The district between the antero-median furrow and the row of hypoglossal nerve fascicles issuing from the medulla receives the name of the anterior pyramid. An inspection of the surface is almost sufficient to show that this is formed by a compact mass of longitudinally directed fibres. It expands somewhat, and assumes a more prominent appearance as it passes upwards, and finally reaching the lower border of the pons Varolii, it becomes slightly constricted and disappears from view by plunging into that structure. The pyramids are the great motor strands of the medulla.

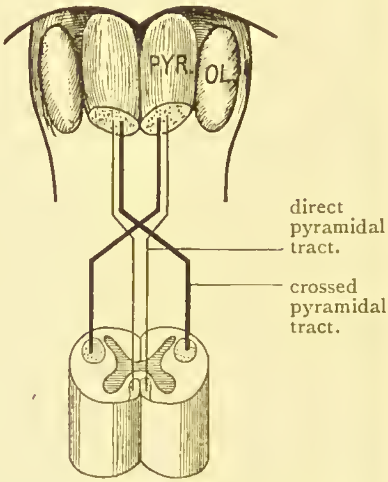


FIG. 309.—Diagram of the decussation of the pyramids.

Although the anterior pyramid at first sight appears to be the continuation upwards of the anterior column of the cord, it contains within itself only a very small proportion of fibres derived from that source. This will be at once manifest if the *decussation of the pyramids* be examined. For this purpose introduce the back of the knife-blade into the antero-median furrow below the decussation, and on one side push forcibly outwards the anterior column of the cord. The pyramid will then be seen to divide at this level into two portions, viz., a small strand termed the *direct pyramidal tract*, which proceeds downwards into the anterior column of the cord, and takes up a position close to the antero-median furrow, and a much larger strand called the *crossed pyramidal tract*, which at this level is broken up into three or more coarse bundles which sink backwards, and, at the same time, cross the mesial plane to

take up a position in the opposite lateral column of the cord, close to the posterior horn of grey matter. It is the inter-crossing of the corresponding bundles of the crossed pyramidal tracts of opposite sides which produces this characteristic decussation.

But if only the direct pyramidal tract in the anterior column of the cord is prolonged upwards into the corresponding district in the medulla, it may be asked: What becomes of the larger lateral part of the anterior column of the spinal cord in the medulla? It is thrust aside by the decussating bundles of the crossed pyramidal tract, and thus comes to occupy a deep position in the medulla.

Lateral Area of the Medulla.—This is the district on the surface of the medulla which is included between the two rows of nerve roots, viz., the hypoglossal roots in front, and the root fascicles of the spinal accessory, vagus and glosso-pharyngeal behind. It presents a very different appearance in its upper and lower parts. In its lower portion it appears to the eye as a continuation upwards of the lateral area of the cord; in its upper part is seen the striking oval prominence, which receives the name of the *olivary eminence.*

The lower part of this district, however, is very far from being an exact counterpart of the lateral column of the cord. As we have already observed, the large crossed pyramidal tract, which in the cord lies in the lateral column, is no longer present in this district of the medulla; it has been transferred at the decussation of the pyramids to the pyramidal tract of the opposite side. Another small strand of fibres, the *direct cerebellar tract*, prolonged upwards in the lateral column of the cord, gradually leaves this portion of the medulla. This tract of fibres lies on the surface, and it is often visible to the naked eye as a white streak inclining obliquely backwards into the posterior district of the medulla to join its upper part, *i.e.*, the restiform body. The great majority of the remainder of the fibres which are prolonged upwards from the lateral column of the cord disappear from

the surface at the lower border of the olivary eminence, by dipping into the substance of the medulla under cover of that projection. A narrow band, however, may be noticed to be carried upwards to the pons in the interval which exists between the posterior border of the olive and the roots of the vagus and glosso-pharyngeal nerves.

The *olivary eminence* is a smooth oval projection, which occupies the upper part of the lateral area of the medulla. Its long axis, which is vertical, is about half an inch long, and its upper end is separated from the lower border of the pons by a narrow interval or groove.

The Posterior Area of the Medulla.—In its lower half this district is bounded behind by the postero-median fissure, and in its upper half by the lateral margin of the medullary portion of the floor of the fourth ventricle. In front it is separated from the lateral area by the row of root-fascicles belonging to the spinal accessory, vagus, and glosso-pharyngeal nerves. As in the lateral area we recognise a lower portion and an upper portion or restiform body, which are quite distinct from each other.

The lower part of the posterior area corresponds more or less closely with the posterior columns of the cord. It will be remembered that in the cervical part of the cord the posterior columns are divided by a distinct septum of pia mater into an inner postero-median strand (column of Goll), and an outer postero-external strand (column of Burdach). These are prolonged upwards into the medulla, and in the lower part of the posterior area they stand out distinctly, and are separated from each other by a continuation upwards from the cord of the paramedian groove. In the medulla these strands receive different names. The inner one is called the *funiculus gracilis*, whilst the outer one is designated the *funiculus cuneatus*. Each of these strands, when it reaches the lower part of the floor of the fourth ventricle, ends in a slightly expanded prominence. The swollen extremity of the funiculus gracilis is called the

clava; it is thrust aside from its neighbour of the opposite side by the opening up of the medulla to form the floor of the fourth ventricle, and the central canal of the cord opens on the surface in the angle between the two clavæ. The thickened end of the cuneate funiculus receives the name of the *cuneate tubercle*, but it is only in the young brain that it is well marked.

In sections through this region of the medulla, it is seen

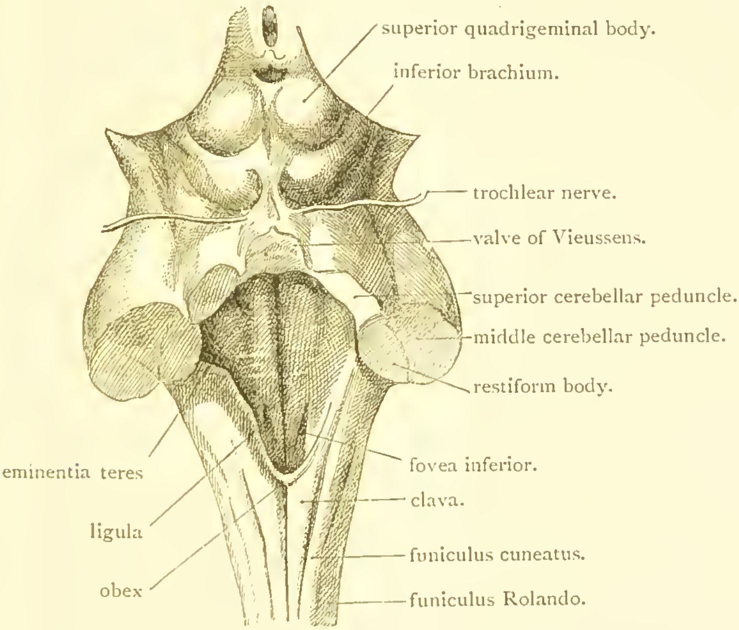


FIG. 310.—Dorsal view of the medulla, pons, and mesencephalon, after removal of the cerebellum. (From GEGENBAUR.)

that the prominences produced by these two strands and of their enlarged extremities is in a great measure due to the presence of two rod-shaped nuclei or collections of grey matter which lie subjacent to them, and which gradually increase as they are traced upwards. These are termed respectively the *gracile* and the *cuneate nuclei*, and it can be easily shown that, as the grey matter increases in quantity

the fibres of the two corresponding strands diminish in number. Indeed, it is doubtful if any of their fibres are prolonged upwards beyond the level of the nuclei.

But a third longitudinal elevation is also apparent in the lower part of the posterior area of the medulla. This is placed on the outer side of the funiculus cuneatus—between it and the posterior row of nerve roots—and it has no counterpart in the posterior column of the cord. It is called the *funiculus of Rolando*, because it is produced by the substantia gelatinosa Rolando approaching the surface along this line. Extremely narrow below, the funiculus of Rolando widens somewhat as it is traced upwards, and finally ends in an expanded extremity called the *tubercle of Rolando.*

The *restiform body* forms the upper part of the posterior area. It lies between the lower part of the floor of the fourth ventricle and the roots of the vagus and glosso-pharyngeal nerves, and is thrust outwards by the opening up of the medulla. It is a large rope-like strand, which inclines upwards and outwards, and then finally takes a turn backwards, and enters the cerebellum, of which it constitutes *the inferior peduncle.* The restiform body, therefore, is to be regarded as the main connection between the cerebellum above and the medulla and spinal cord below. At the same time, it must be understood that it is not formed of fibres which are prolonged into it from the funiculus gracilis and funiculus cuneatus of its own side. It is true that a surface inspection of the medulla might very naturally lead to this supposition, because there is no sharp line of demarcation marking it off from the tubercles of these strands.

The fibres which build up the restiform bodies come from several different sources. It will be sufficient to indicate the more important of these—(1) from the gracile and cuneate nuclei of the same side in the form of *posterior superficial arcuate fibres;* (2) from the gracile and cuneate nuclei of the opposite side in the form of *anterior superficial*

arcuate fibres; (3) from the convoluted nucleus of the olivary body of the opposite side; and (4) from the lateral column of the spinal cord through the *direct cerebellar tract.*

Superficial Arcuate Fibres.—On the surface of the medulla, more particularly in the neighbourhood of the lower border of the olive, a number of curved bundles of fibres, termed the *superficial arcuate fibres*, may be noticed. They vary very greatly in number and in dis-

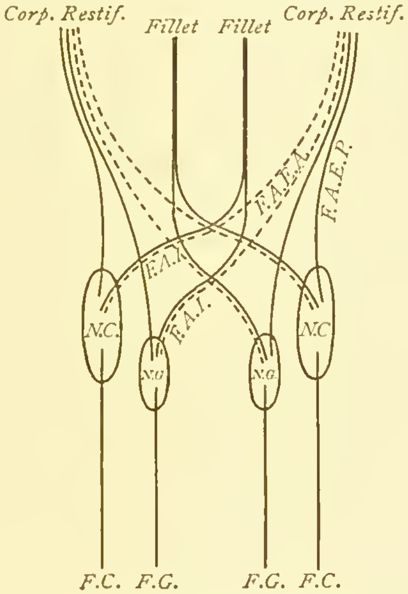


FIG. 311.—Diagram of the connections of the gracile and cuneate nuclei. (From BRUCE.)

F.C. Funiculus cuneatus.
N.C. Nucleus cuneatus.
F.G. Funiculus gracilis.
N.G. Nucleus gracilis.
F.A.E.P. Posterior superficial arcuate fibres.
F.A.E.A. Anterior superficial arcuate fibres.
F.A.I. Deep arcuate fibres.

tinctness, and they are sometimes so numerous as to cover over almost entirely the olivary eminence. An attentive examination will show that they come to the surface in the antero-median groove between the pyramids, and frequently in the groove between the pyramid and the olive. But at whatever point they reach the surface, they all have one

destination, viz., the restiform body—a considerable part of which they form.

Dissection.—The anterior pyramid of one side should now be carefully raised. When dislodged from its bed it should be gently pulled upwards towards the pons Varolii. In this way its entrance into the pons is brought very clearly into view, and further, numerous arcuate fibres will be seen running forwards across the mesial surface of the opposite pyramid to reach the surface.

Very little of the structure of the medulla can be learnt from specimens obtained in the dissecting room. Further, it is not advisable to cut into the medulla at present, because the student has still to study that portion of its dorsal surface which forms the lower part of the floor of the fourth ventricle, and this cannot advantageously be done until the cerebellum has been examined. Still, it is convenient to say what little has to be said on the structure of the medulla at this stage.

Structure of the Medulla.—When transverse sections are made through the medulla at different levels, a faint line called the median raphe, and occupying the mesial plane, is seen to divide it into two exactly similar lateral portions. The raphe is formed by the close intersection of fibres running in different directions.

Each half of the medulla is composed of (*a*) strands of white matter; (*b*) grey matter, which is present both in the form of direct continuations into the medulla of portions of the grey matter of the cord, and also in the form of isolated clumps, which are not represented in the cord; and (*c*) the formatio reticularis, a substance which is composed of grey matter coarsely broken up by fibres which traverse it in different directions. The white matter, as in the cord, is for the most part disposed on the surface and the grey matter in the interior, but in the open part of the medulla the grey matter comes to the surface on its dorsal aspect, and is spread out over that area which forms the medullary portion of the floor of the fourth ventricle.

When the grey matter of the cord is traced up into the medulla, many striking changes in its arrangement become apparent. Owing to the increase in size of the large wedge-shaped gracile and cuneate funiculi, the posterior horns of grey matter become folded outwards, so that they soon assume a position at right angles to the mesial plane, and lie very nearly in the same transverse line. At the same time, the cuneate and gracile nuclear columns of grey matter which grow out from the basal portion of this horn and underlie the strands of the same name, begin to make their appearance. From the deep aspect of these nuclei, fibres, which take origin within them, stream forwards and inwards through the cervical portion of the posterior horn, so as to reach the raphe.

The caput cornu is in this way completely cut off from the basal portion. The latter remains in close relation to the central canal, whilst the caput or substantia gelatinosa Rolandi is placed close to the surface, enlarges as it is traced upwards, and forms the prominence on the surface which has already been described as the funiculus and tubercle of Rolando. The fibres which have thus broken up the cervical part of the posterior horn, and which come from the cuneate and gracile nuclei, are termed the *internal* or *deep arcuate fibres.* They reach the raphe on the deep or dorsal aspect of the pyramids, and, crossing the mesial plane, they form a very complete decussation with the corresponding fibres of the opposite side, which is termed the *decussation of the fillet* or the *sensory decussation*, in contradistinction to the term *motor decussation*, which is sometimes applied to the crossing of the pyramids. As soon as they reach the opposite side of the medulla, these *internal* or *deep arcuate fibres* turn upwards and form a longitudinal tract, placed close to the raphe and on the dorsal aspect of the corresponding pyramid, which receives the name of the *fillet* or *lemniscus.*

The anterior horn of grey matter shares a like fate in the medulla at the hands of the crossed pyramidal tract. This great bundle, in passing from the pyramid into the lateral column of the cord of the opposite side, traverses the anterior horn so as to completely break up its intermediate part and separate its head from its basal portion. The further history of the detached head we need not trace, but it is well to observe that the basal part remains in position on the ventral and lateral aspect of the central canal.

As we proceed up the closed part of the medulla, the central canal, surrounded by the basal portions of the two horns of grey matter, gradually inclines towards the dorsal aspect, until it finally opens on the surface. The grey matter which surrounds it is now spread out on the floor of the fourth ventricle, and in such a manner that the portion which corresponds to the basal part of the anterior horn of the cord is situated close to the mesial plane, whilst the part which represents the base of the posterior horn occupies a more lateral position. This is important, because the nucleus of origin of the hypoglossal nerve is placed in the mesial part of the floor, whilst the nuclei of origin of the vagus and glosso-pharyngeal nerves lie in the lateral part of the floor.

The most conspicuous of the isolated clumps of grey matter in the medulla are the olivary nucleus and the two accessory olivary nuclei. The *olivary nucleus* lies subjacent to the olivary eminence, and is a very conspicuous object in transverse sections through this region. In such cases it presents the appearance of a thick wavy or undulating line of grey matter folded upon itself so as to enclose a space filled with

white matter and open towards the mesial plane. It is in reality a lamina arranged in a purse-like manner with its open mouth directed towards the raphe. The fibres which enter through its mouth constitute the *olivary peduncle.*

The *accessory olivary nuclei* are two band-like laminæ of grey matter, which are respectively placed on the dorsal and mesial aspects of the main nucleus. When seen in transverse section each of these nuclei presents a rod-like appearance (Fig. 312, o^1 and o^2.)

Behind, or deeper than, the olive on the one hand, and the pyramid on the other, is the *formatio reticularis* of the medulla. It forms a large

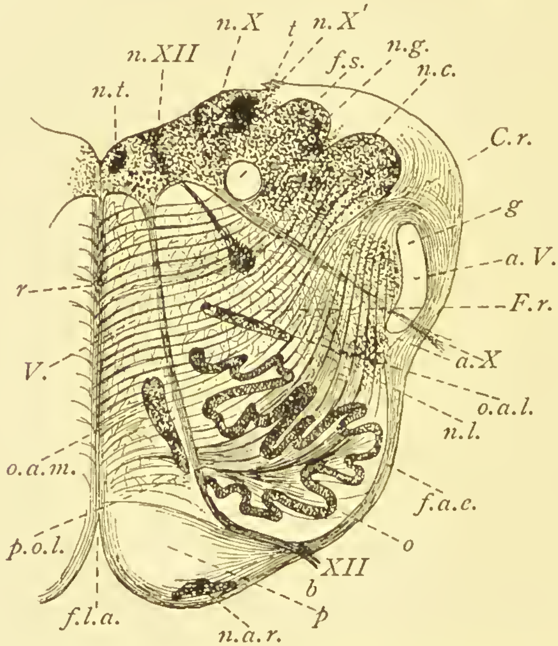


FIG. 312.—Section through the medulla oblongata at the leve of the middle part of the olive. (SCHWALBE.)

f.l.a., anterior median fissure; *n.a.r.*, nucleus arciformis; *p.*, pyramid; *XII.*, fascicle of bypoglossal nerve; *o.*, olivary nucleus; *f.a.c.*, superficial arcuate fibres; *n.l.*, nucleus lateralis; *a.*, arcuate fibres; *X.*, vagus root; *F.r.*, formatio reticularis grisea; *a.V.*, ascending root of fifth nerve; *g.*, fibres passing from olive of opposite side to restiform body; *c.r.*, restiform body; *n.c.*, nucleus cuneatus; *n.g.*, nucleus gracilis; *t.*, ligula; *f.s.*, funiculus solitarius; *n.X.*, vagus nucleus; *n.XII.*, hypoglossal nucleus; *n.t.*, nucleus of funiculus teres; *r.*, raphe; *o.a.m. and o.a.l.*, accessory olivary nuclei; *p.o.l.*, olivary peduncle; *V.*, formatio alba.

part of its substance, and is divided into a lateral and a mesial field by the nerve fascicles of the hypoglossal as they traverse the substance of the medulla to reach the surface. In the lateral portion, which lies behind the olive, there is a considerable quantity of grey matter, continuous with that of the cord, present in the reticular formation ; it is therefore called the *formatio grisea*. In the mesial part, however, which lies behind the pyramid, the grey matter is extremely scanty, and the reticular matter here is termed the *formatio alba*.

The nerve fibres which traverse the formatio reticularis run both in the transverse and in the longitudinal direction. The *transverse fibres* are the *deep* or *internal arcuate fibres*. The *longitudinal fibres* are derived from different sources in the two fields. In the lateral part of the formation they represent the fibres of the lateral column (after the removal of the direct cerebellar and the crossed pyramidal tracts) which are continued up under cover of the olive. In the anterior part, or formatio alba, the longitudinal fibres are largely derived from that portion of the anterior column of the cord which lies on the outer side of the direct pyramidal tract (ground-bundle), and which is thrust into the substance of the medulla by the crossing of the pyramids.

In this position also two longitudinal strands take origin, viz., the fillet and the posterior longitudinal bundle. Both lie close to the raphe. The *fillet* is placed immediately behind the pyramid, and is formed, as described, by the decussating internal arcuate fibres. The *posterior longitudinal bundle* takes form in the upper part of the medulla, immediately subjacent to the grey matter of the floor of the fourth ventricle. It is formed by longitudinal fibres of the formatio alba which come from the ground-bundle of the anterior column of the cord.

Pons Varolii.—The pons Varolii is the marked prominence on the base of the brain which is interposed between the medulla and the crura cerebri, and which lies in front of the cerebellum. It is convex from side to side, as well as from before backwards, and the transverse streaks on its surface show that superficially it is composed of transverse bundles of nerve fibres. On either side, these transverse fibres collect themselves together so as to form a large compact strand which sinks in a backward and outward direction into the white matter of the corresponding hemisphere of the cerebellum. This strand is termed the *middle cerebellar peduncle*.

The ventral surface of the pons is in relation to the basilar

process of the occipital bone and the dorsum sellæ of the sphenoid bone. It presents a mesial groove which gradually widens as it is traced upwards. In this lies the basilar artery, but the groove is not caused by this vessel, but is due to the prominence which is produced on either side by the passage upwards through the pons of the pyramidal bundles of the medulla. Where the pons Varolii becomes the cerebellar peduncle the large trigeminal nerve will be seen emerging from its ventral surface nearer its upper than its lower border.

With the exception of the restiform bodies, the whole of the medulla enters the lower aspect of the pons, and its constituent parts are carried upwards within it. The crura cerebri emerge from its upper aspect. The *dorsal surface* of the pons cannot be studied at present. It is turned towards the cerebellum, which hides it from view. It forms the upper part of the floor of the fourth ventricle.

Cerebellum.—The cerebellum is distinguished by the numerous parallel and more or less curved sulci which traverse its surface and give it a foliated appearance. As in the case of the cerebral hemispheres, the grey matter is spread over the entire surface, whilst the white matter forms in the interior a central core.

In the cerebellum we recognise a median portion termed the *vermis*, and two lateral and much larger portions, called the *lateral hemispheres.* The distinction between these main subdivisions of the organ is not very evident from every point of view. In front and behind there is a marked deficiency or notch (Fig. 313). The *posterior notch*, termed the *incisura marsupialis*, is smaller and narrower than the anterior notch. It is bounded laterally by the hinder parts of the cerebellar hemispheres, whilst its bottom is formed by the central lobe or vermis. It is occupied by the falx cerebelli. The *anterior notch*, also termed the *incisura semilunaris*, is shallower but much wider than the marsupial notch. When viewed from above, it is seen to be occupied by the inferior pair of

quadrigeminal bodies and the superior cerebellar peduncles. As in the case of the marsupial notch, the sides are formed by the lateral hemispheres and the bottom by the vermis.

On the *superior surface* of the cerebellum, there is little distinction to be noted between the central lobe and the upper surface of each lateral hemisphere. The central lobe or *superior vermis* forms a median elevation, from which the surface slopes gradually downwards on each side to the margin of the hemisphere. The vermiform elevation is highest in front, immediately behind the semilunar notch, and from this it gradually inclines downwards towards the marsupial notch. It receives the name of the *monticulus cerebelli*. The folia on the surface of the vermis superior will be seen to be thicker and fewer in number than those on the upper surface of the lateral hemisphere. It is this that gives it the worm-like appearance from which its name is derived.

On the *inferior surface* of the cerebellum, the distinction between the three constituent parts of the organ is much better marked. On this aspect the lateral hemispheres, which are full, prominent, and convex, are separated by a deep, mesial hollow, which is continued forwards from the marsupial notch. This hollow is termed the *vallecula cerebelli*, and in its fore part is lodged the medulla oblongata. When the medulla is raised, and the lateral hemispheres pulled apart so as to expose the bottom of the vallecula, it will be seen that this is formed by the *vermis inferior*, and, further, that the latter is separated on each side from the corresponding lateral hemisphere by a distinct furrow, termed the *sulcus valleculæ*.

When the margin of the cerebellum, where it forms the bottom of the semilunar notch on the superior aspect of the organ, is gently pushed backwards, and the mesencephalon pulled forwards, two strands lying upon the dorsal aspect of the pons Varolii will be seen. These are the *superior cerebellar peduncles*. Emerging from the white matter of

the cerebellum, they converge as they proceed upwards, and finally they disappear under the inferior quadrigeminal bodies. The thin lamina which is stretched across between them is the *valve of Vieussens*, or the *superior medullary velum.* It is continuous below with the white core of the cerebellum, and it forms the roof of the upper part of the fourth ventricle. From its dorsal surface, close to the inferior quadrigeminal body, the small trochlear nerves emerge.

Certain of the fissures which traverse the surface of the cerebellum, deeper and longer than the others, map out districts which are termed lobes. The most conspicuous of all these clefts is the *great horizontal fissure.*

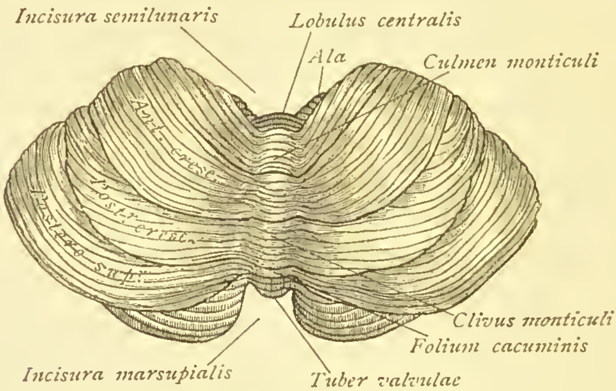


FIG. 313.—Upper surface of the cerebellum. (From SCHWALBE.)

Great Horizontal Fissure of the Cerebellum.—The great horizontal fissure begins in front, and passes round the circumference of the cerebellum, cutting deeply into its outer and posterior margins. In front, its lips diverge from each other so as to enclose the large middle peduncle, where it passes into the interior of the cerebellum. This fissure divides the organ into an upper and a lower part, which may be studied separately.

Lobes on the Upper Surface of the Cerebellum.—When examined from before backwards, the vermis superior

presents the following subdivisions:—(1) the lingula; (2) the central lobe; (3) the culmen monticuli; (4) the clivus monticuli; (5) the folium cacuminis. With the exception of the lingula, each of these is continuous on either side with a corresponding district on the upper surface of the hemisphere, thereby forming a cerebellar lobe. Thus, the central lobe is prolonged outwards in an expansion called the *ala;* the culmen constitutes a central connecting piece between the two *anterior crescentic lobules* of the hemispheres; the clivus stands in the same relation to the *posterior crescentic lobules;* and the folium cacuminis is the connecting band between the *postero-superior lobules* of the hemispheres.

The Lingula.—The lingula can only be seen when the bottom of the semilunar notch is pushed backwards. It consists of four or five small folia continuous with the grey matter of the vermis superior, and prolonged forwards on the surface of the valve of Vieussens or superior medullary velum in the interval between the superior cerebellar peduncles.

Lobus Centralis with its Alæ.—The central lobe lies at the bottom of the semilunar notch, and is only seen to a very small extent on the upper surface of the organ. It is a little central mass which is prolonged outwards for a short distance round the semilunar notch in the form of two expansions, termed the *alæ.*

Lobus Culminis.—The *culmen monticuli* constitutes the summit or highest part of the monticulus of the vermis superior. It is prolonged outwards on either side into the corresponding hemisphere as the *anterior crescentic lobule.* This is the most anterior subdivision on the upper surface of the hemisphere. The two anterior crescentic lobules, with the culmen monticuli, form the *lobus culminis cerebelli.*

Lobus Clivi.—The *clivus monticuli* lies behind the culmen, from which it is separated by a distinct fissure, and it forms the sloping part or descent of the monticulus of the vermis

superior. On each side it is continuous with the *posterior crescentic lobule* of the lateral hemisphere, and the three parts are included under the one name of *lobus clivi.*

The two crescentic lobules on the upper surface of the hemisphere are frequently described together as the *quadrate lobule.*

Lobus Cacuminis.—The *folium cacuminis* forms the most posterior part of the vermis superior, and it bounds the great horizontal fissure superiorly at the posterior or marsupial notch. It is a single folium, the surface of which may be smooth or beset with rudimentary secondary folia. It is the connecting link between the two *postero-superior lobules* of the hemispheres—the three parts constituting the *lobus cacuminis.* As the folium cacuminis is traced outwards into the postero-superior lobule of the hemisphere, it is found to expand greatly. The result of this is that the postero-superior lobule on each side is an extensive foliated district bounding the hinder part of the great horizontal fissure above.

Lobes on the under surface of the Cerebellum.—The connection between the several parts of the vermis inferior and the corresponding districts on the under surface of the two hemispheres, is not nearly so distinct as in the case of the vermis superior and the lobules on the upper surface of the hemispheres. A groove, the *sulcus valleculæ*, intervenes between the vermis inferior and the hemisphere on each side.

From behind forwards the following subdivisions of the vermis inferior may be recognised—(1) the tuber valvulæ, (2) the pyramid, (3) the uvula, and (4) the nodule.

On the under surface of the hemisphere there are five lobules mapped out by intervening fissures. These are—(1) the *flocculus*, a little lobule lying on the middle peduncle of the cerebellum ; (2) the *biventral lobule*, which lies immediately behind the flocculus, and is partially divided into two parts by a fissure which traverses its surface ; (3) the

tonsil or *amygdala*, a rounded lobule, which bounds the vallecula on the inner side of the biventral lobule; (4) the *slender lobule* (lobulus gracilis), a narrow crescentic strip of cerebellar surface which is situated behind the biventral lobule; (5) the *postero-inferior lobule* placed behind the slender lobule, and bounding the great horizontal fissure below.

These lobules of the hemispheres, with the corresponding portions of the vermis inferior, constitute the lobes on the under aspect of the cerebellum.

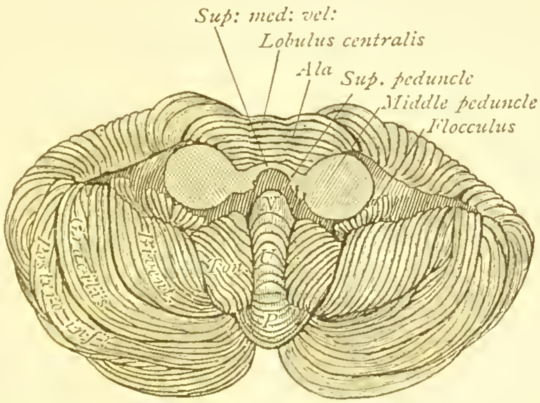


FIG. 314.—Lower surface of the cerebellum. (From SCHWALBE.)

N. Nodule. *U.* Uvula. *P.* Pyramid.

Lobus Noduli.—The lobus noduli comprises the nodule and the flocculus with an exceedingly delicate connecting lamina of white matter, termed the *inferior medullary velum*.

The velum cannot be properly seen at present, but it will be exposed at a later stage of the dissection.

Lobus Uvulæ.—The uvula is a triangular elevation placed between the two tonsils. It is connected across the sulcus valleculæ with each tonsil by a low-lying ridge of grey matter scored by a few shallow furrows, and in consequence termed the *furrowed band*. The two tonsils and the uvula form the lobus uvulæ.

To see the furrowed band it will be necessary to remove the tonsil on one side.

Lobus Pyramidis.—The pyramid is connected with the biventral lobule on each side by a faint ridge which crosses the sulcus valleculæ. The term *lobus pyramidis* is given to the three lobules which are thus associated with each other.

Lobus Tuberis.—The *tuber valvulæ*, which forms the most posterior part of the vermis inferior, is composed of several folia, which run directly into the postero-inferior lobule. The slender lobule is not directly connected with

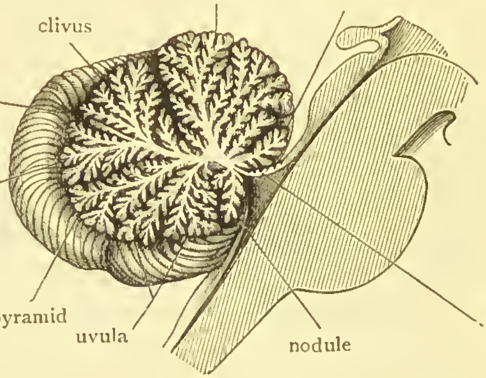


FIG. 315.—Mesial section through the vermis of the cerebellum. (From GEGENBAUR).

the tuber valvulæ, but it is included with it and the postero-inferior lobule in the *lobus tuberis*.

Dissection.—A mesial section should now be made through the vermis of the cerebellum and the two medullary vela into the cavity of the fourth ventricle. When the two parts of the cerebellum are drawn slightly asunder, a view of the fourth ventricle is obtained; further, the connections of the two medullary vela and the arrangement of the peduncles of the cerebellum can be more clearly understood.

Arbor Vitæ Cerebelli.—The cut surface of the cerebellum presents a very characteristic appearance. The grey matter on the surface stands out distinctly from the white matter in

the interior. Further, the complete manner in which the surface is cut up by the fissures and sulci into secondary and tertiary folia is seen. The central mass of white matter is termed the *corpus trapezoides.* From this, main prolongations pass into the various lobules, and these give off branches so as to supply each folium with a central white stem or core. The term *arbor vitæ* is applied to the appearance which consequently results when a section is made through the cerebellum.

Cerebellar Peduncles.—These are three in number on each side—viz., the middle, the superior, and the inferior. They are all directly connected with the white medullary centre of the cerebellum, and are composed of fibres which emerge from or enter the white central substance of the organ.

The *middle peduncle* is much the largest of the three. It is formed by the transverse fibres of the pons, and it enters the cerebellar hemisphere on the outer side of the other two. The lips of the anterior part of the great horizontal fissure are separated widely from each other to give it admission. Within the cerebellar hemisphere its fibres are distributed in two great bundles. Of these, one composed of the upper transverse fibres of the pons, radiates out in the lower part of the hemisphere; whilst the other, consisting of the lower transverse fibres of the pons, spreads out in the upper part of the hemisphere.

The *inferior peduncle* is simply the restiform body of the medulla. It emerges from the white matter of the cerebellar hemisphere between the other two peduncles. At first directed forwards, it then turns sharply downwards so as to form the upper part of the posterior area of the medulla (*i.e.*, the restiform body).

The *superior peduncles* are composed of fibres which for the most part come from the corpus dentatum of the cerebellar hemisphere. As they issue from the cerebellum, each peduncle lies close to the inner side of the corresponding

middle peduncle. They then proceed upwards towards the inferior pair of quadrigeminal bodies. At first they form the lateral boundaries of the upper part of the fourth ventricle, but they converge as they ascend on the dorsal aspect of the pons Varolii, so that ultimately they come to overhang that cavity and enter into the formation of its roof. They disappear under cover of the quadrigeminal bodies, and their course in the mesencephalon has already been described.

Medullary Vela.—The medullary vela are closely associated with the peduncles. They consist of two thin laminæ of white matter which are projected out from the white central core of the cerebellum. The *superior medullary velum*, or *valve of Vieussens*, stretches across the interval between the two superior cerebellar peduncles, with the inner margins of which it is directly continuous. It is triangular in form, and when traced downwards it is seen to be carried with the superior peduncles into the white matter of the cerebellum. Spread out on its dorsal surface is the tongue-shaped prolongation of grey matter from the cortex of the cerebellum, which is termed the *lingula*, and issuing from its substance close to the inferior quadrigeminal bodies are the two trochlear nerves.

The *inferior medullary velum* is somewhat more complicated in its connections. It presents the same relation to the nodule that the superior velum presents to the lingula. It is a wide thin lamina of white matter—so thin that it is translucent—which is prolonged out from the white centre of the cerebellum above the nodule. From the nodule it stretches outwards to the flocculus, thereby bringing these two small portions of the cerebellum into association with each other. Where it issues from the white matter of the cerebellum, it might almost be said to be in contact with the superior medullary velum, but as the two laminæ are traced forwards they diverge from each other: the superior velum is carried upwards between the superior peduncles

of the cerebellum, whilst the inferior medullary velum turns downwards round the nodule, and ends in a slightly thickened free crescentic edge. The cavity of the fourth ventricle is carried backwards between the two vela, which form a tent-like roof for it.

Fourth Ventricle.—This cavity is somewhat rhomboidal in form. Below, it tapers to a point and becomes continuous with the central canal of the cord; above, it narrows in a similar manner and is continued into the aqueduct of Sylvius. The posterior wall is called *the roof.* The anterior wall is termed *the floor*, and is formed by the dorsal surface of the medulla and pons. On either side a narrow pointed prolongation of the ventricular cavity is carried outwards from its widest part round the upper part of the corresponding restiform body. This is termed the *lateral recess* (Fig. 293, p. 534). Looking into the cavity between the two portions of the mesially divided cerebellum the lateral recess is very apparent.

Floor of the Fourth Ventricle.—In its lower part the floor of the fourth ventricle is formed by the dorsal surface of the open part of the medulla, whilst in its upper part it is formed by the dorsal surface of the pons Varolii. The area thus constituted is distinctly lozenge-shaped, its widest part being opposite the middle peduncles of the cerebellum. Further, it is circumscribed by definite lateral boundaries. Thus below, it is bounded on either side by the clava, the cuneate tubercle, and the restiform body; whilst above, the lateral limit is formed by the superior cerebellar peduncle.

The floor of the fourth ventricle is divided into two symmetrical and lateral portions by a median groove. At the lower narrow end, between the two clavæ, it receives the name of the *calamus scriptorius*, from its fancied resemblance to the point of a pen. Crossing each half of the floor at its widest part are several transverse bundles of fibres termed the *striæ acusticæ.* They appear to emerge from the mesial groove, and they are carried outwards over the restiform

body. Their connections are somewhat obscure, but the majority of the fibres are believed to pass on to the flocculus. The striæ acusticæ divide each lateral half of the ventricular floor into an upper and a lower portion, which very nearly correspond to the subdivisions of this area formed by the medulla and the pons. On the lower medullary district a small triangular depression, placed immediately below the striæ acusticæ, catches the eye. This is termed the *fovea inferior*. It is shaped somewhat like an arrow-head. The apex or point looks towards the striæ, whilst the lateral angles of the base are prolonged downwards in the form of diverging grooves. Of these, the inner groove runs towards the opening of the central canal at the calamus scriptorius, whilst the outer groove runs towards the lateral boundary of the floor. In this manner the portion of the floor which lies below the striæ acusticæ is mapped out into three triangular areas. The mesial subdivision is slightly elevated, and is termed the *trigonum hypoglossi*, because subjacent to this area is the nucleus of origin of the hypoglossal nerve. The intermediate area between the diverging grooves which proceed from the base of the fovea inferior is the *trigonum vagi*, so called because the vagus and glosso-pharyngeal nuclei lie subjacent to it. The external area is the *trigonum acustici*. The base of this area is directed upwards and runs continuously into an eminence, the *acoustic tubercle*, over which the striæ acusticæ pass. Subjacent to this region of the floor of the ventricle the principal part of the auditory nerve takes origin.

On the part of the floor of the ventricle which lies above the striæ acusticæ, and which corresponds to the dorsal surface of the pons, there is also a slight depression. This is termed the *fovea superior*. Between it and the median groove there is a marked prominence, termed the *eminentia teres*. Inferiorly, this elevation passes downwards and becomes continuous with the trigonum hypoglossi, whilst above it is carried upwards towards the opening of the

aqueduct of Sylvius. In both directions it becomes gradually less prominent, but still it forms a distinct elongated elevation which stretches along the whole length of the median groove. It is termed the *fasciculus teres.* Proceeding upwards from the fovea superior to the opening of the Sylvian aqueduct there is a shallow depression, termed the *locus cœrulens.* When the ependyma is scraped away from the surface of this part of the floor, some dark pigmented substance, termed the *substantia ferruginea*, will be exposed.

Roof of the Fourth Ventricle.—In its upper part the roof of the fourth ventricle is formed by the superior medullary velum as it stretches across between the two superior cerebellar peduncles, and also to some extent by the approximation of these peduncles themselves as they approach the mesencephalon.

In its lower part the roof of the ventricle is exceedingly thin, and is not all formed of nervous matter. The inferior medullary velum enters into its formation, and where this fails the epithelial lining of the cavity, supported by pia mater is carried downwards towards the lower lateral boundaries of the ventricle. At the lowest part of the calamus scriptorius, and also along each lateral boundary, a thin lamina of white matter is carried for a short distance over the epithelial roof. The small lamina at the calamus scriptorius overhangs the opening of the central canal, and is termed the *obex.* The lamina in relation to the lateral boundary of the ventricle is more extensive, and is called the *ligula.* It begins on the clava, and passes upwards along the cuneate tubercle to the restiform body. On the surface of this it turns outwards so as to bound the lateral recess below, and in some cases it may be seen to become continuous round the extremity of the lateral recess with the inferior medullary velum.

A short distance above the calamus scriptorius there is an aperture in the epithelial roof of the fourth ventricle, by

means of which the cavity of the ventricle communicates with the subarachnoid space. This opening is termed the *foramen of Magendie*. There is also an aperture of a similar character in the epithelial roof of each lateral recess.

Two *choroid plexuses*, one on either side of the mesial plane, invaginate the roof of the fourth ventricle in such a way that they appear to lie within the cavity. Offshoots from these likewise protrude into the lateral recesses.

Dissection.—The dissector should now introduce his fingers into the great horizontal fissure of the right half of the cerebellum, and gently tear the upper part of this side of the organ away from the lower part. By this proceeding the manner in which the peduncles enter the white medullary centre, and also to some extent the general distribution of their fibres will be seen.

Both portions of the cerebellum should, in the next place, be removed by cutting through the peduncles at the points where they enter the central white matter. A horizontal section may then be made through the left half of the organ, rather nearer its upper surface than its lower surface. This will reveal the corpus dentatum.

Corpus Dentatum of the Cerebellum.—This is a collection of grey matter, embedded in the white medullary centre of the lateral hemisphere of the cerebellum, which presents an appearance very similar to that of the olivary nucleus of the medulla. It is a thin lamina of grey matter, which appears on section as a wavy line folded upon itself, so as to form a crumpled grey capsule with an open mouth towards the mesial plane. The greater number of the fibres which build up the superior cerebellar peduncle issue from its mouth.

There are other smaller isolated nuclei of grey matter in the white medullary centre of the cerebellum, but these cannot, as a rule, be demonstrated in a specimen obtained in the dissecting-room. They lie nearer the mesial plane.

Dissection.—A series of transverse sections should now be made through the pons Varolii and the medulla, in order that something of their internal structure may be learned. The structure of the medulla is briefly described at p. 574.

Internal Structure of the Pons Varolii.—When transverse sections are made through the pons, it is seen to consist of two well-defined parts,

viz., a ventral and a dorsal. Broadly speaking, the ventral part corresponds with the pyramidal parts of the medulla, and the pedal parts of the crura cerebri; whilst the dorsal part corresponds with the formatio reticularis of the medulla and the tegmental part of the crura cerebri.

The ventral part of the pons is the larger of the two subdivisions. It is composed of a large number of transverse bundles of fibres, through the midst of which the longitudinal bundles of the pyramids are carried upwards, to ultimately enter the crustæ of the crura cerebri. Scattered amongst these fibres we have a certain amount of grey matter termed the *nuclei pontis*. In the lower part of the pons the pyramids are seen in the form of one solid bundle on each side; almost immedi-

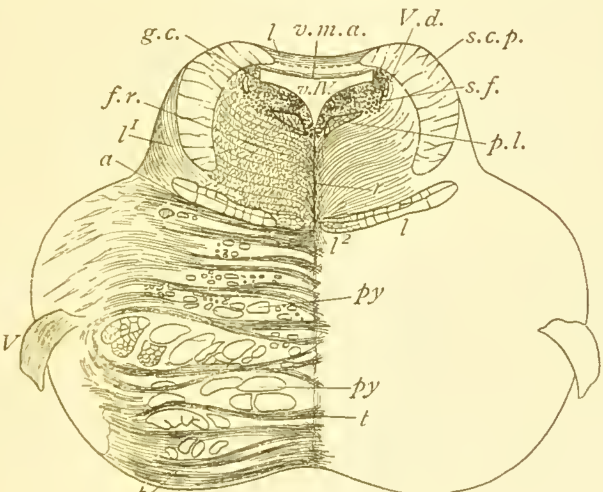


FIG. 316.—Transverse section through the upper part of the pons. (SCHWALBE, after Stilling.)

p. transverse fibres of the pons; *py.* pyramidal bundles; *a.* boundary line between the ventral and dorsal parts of the pons; *l1.* oblique fibres of the lateral fillet; *l.* lateral fillet; *l2.* mesial fillet; *f.r.* formatio reticularis; *p.l.* posterior longitudinal bundle; *s.c.p.* superior cerebellar peduncle; *v.m.a.* superior medullary velum; *l.* grey matter of lingula; *v.IV.* fourth ventricle; *v.d.* descending root of the fifth nerve; *s.f.* substantia ferruginea; *g.c.* nucleus of the aqueduct; *V.* trigeminal nerve; *r.* raphe.

ately, however, these are broken up by intersecting transverse bundles of fibres, so that they spread out and come to occupy a much wider area as they proceed upwards. Of the transverse fibres two distinct sets may be recognised, viz., the superficial transverse fibres, through the midst

of which the pyramidal bundles are prolonged, and a deeper set termed the trapezium. The *superficial transverse fibres* on each side pass into the corresponding middle peduncle of the cerebellum. The *trapezial fibres* lie behind the pyramidal bundles, and are only seen in the lower part of the pons. They are connected with the accessory auditory nucleus.

The *dorsal part of the pons* is for the most part formed of a prolongation upwards of the formatio reticularis of the medulla. Superiorly it is carried into the tegmental parts of the crura cerebri. It is divided into two lateral parts by a mesial raphe continuous below with the raphe of the medulla and above with the raphe of the tegmental part of the mesencephalon, whilst over its dorsal surface is spread a thick layer of grey matter which belongs to the upper part of the floor of the fourth ventricle. In transverse sections through the pons a dark spot in the outer part of this indicates the position of the *substantia ferruginea.*

Three strands of longitudinal fibres are seen on each side in transverse sections through the dorsal part of the pons. These are (1) the fillet, (2) the posterior longitudinal bundle, and (3) the superior cerebellar peduncle.

The *fillet* has now assumed a ribbon-shaped form. It is placed between the ventral part of the pons and the formatio reticularis of the dorsal part. The fibres which form its lateral portion as they pass upwards will be seen in successive sections to curve outwards so as to gain the surface.

The *posterior longitudinal bundle* is much more distinct than it is lower down in the medulla. It has separated itself more completely from the longitudinal fibres of the formatio reticularis, and it is now seen close to the mesial plane immediately subjacent to the grey matter of the floor of the fourth ventricle.

The *superior cerebellar peduncle* in transverse sections presents a semilunar outline. It occupies a lateral position in the dorsal part of the pons, and gradually sinks deeply into its substance, although it does not become completely submerged until it reaches the mesencephalon.

The *superior olive* is a small isolated clump of grey matter which is embedded in the dorsal part of the pons immediately behind the lateral part of the corpus trapezoides. It possesses considerable morphological interest, but it is not likely that the dissector will be able to obtain a view of it in a dissecting-room specimen.

THE AUDITORY APPARATUS.

THE organ of hearing admits of a very natural subdivision into three parts, viz., the external, the middle, and the internal ear. The *external ear* consists of the pinna and the external auditory meatus. The pinna collects the waves of sound, and is, comparatively speaking, of subsidiary im-

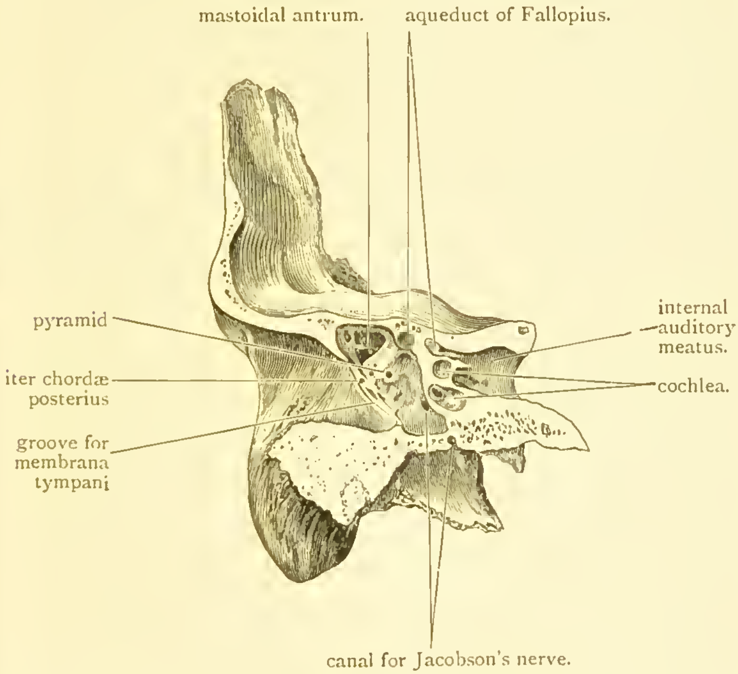


FIG. 317.—Coronal section of the right temporal bone passing through the external and the internal auditory meatuses.

portance in man, although it is highly developed and of considerable service in some of the lower animals. The external auditory meatus is a passage which leads inwards to the membrana tympani from the bottom of the concha. The *middle ear* is a narrow chamber termed the tympanum

or drum of the ear. It is interposed between the external auditory passage and the internal ear or labyrinth, and its outer wall is formed by the membrana tympani. Stretching across the cavity of the tympanum, from its outer to its inner wall, there is a chain of three minute bones called the auditory ossicles. The *internal ear* or labyrinth is the essential part of the organ. It consists of a complicated system of cavities in the densest part of the petrous portion of the temporal bone. These cavities contain fluid called perilymph, and also a membranous counterpart of the bony chambers called the membranous labyrinth. Within the latter there is fluid termed endolymph.

Dissection.—In a temporal bone to which the pinna is still attached the squamous portion should be removed by a horizontal saw-cut at the level of the posterior root of the zygoma. With the chisel and bone forceps the roof and anterior wall of the auditory passage should then be taken away piecemeal, until a good view is obtained of the outer surface of the membrana tympani.

Meatus Auditorius Externus.—The pinna has already been described (p. 291). The meatus is directed inwards and slightly forwards, and describes a gentle curve, the convexity of which is directed upwards. It is about one inch and a half in length, and in its outer part (about half-an-inch in length) its walls are composed of cartilage and fibrous tissue, whilst in its inner part its walls are bony. The passage is narrower in the inner bony portion than in the outer cartilaginous part. The skin lining the cartilaginous portion is abundantly furnished with ceruminous glands, and is also provided with outwardly-directed hairs, which tend to prevent the entrance of dust. The cutaneous lining of the inner half, which is thin and tightly adherent to the subjacent periosteum, is destitute of hairs, and glands are for the most part absent. A small patch of glands, however, is found at the upper and back part of the osseous meatus, at its junction with the cartilaginous portion. The cutaneous lining of the meatus is continued in the form of

an exceedingly delicate layer over the outer surface of the membrana tympani.

If the subject is slightly decomposed the cuticular lining of the meatus may be drawn out entire, like the finger of a glove, and the epidermal covering of the membrana tympani is thus demonstrated.

Dissection.—The tympanic cavity can be most conveniently opened for inspection by the removal of its roof. The roof is formed by a thin scale of bone (tegmen tympani) which extends beyond the limits of the tympanum and covers in the canal for the tensor tympani in front and the mastoidal antrum behind. An opening should be made through the tegmen tympani, immediately external to the elevation formed by the superior semicircular canal, and about three-eighths of an inch in front of the superior border of the petrous bone. This will open into the mastoidal antrum. The opening can then be cautiously enlarged with chisel and bone forceps until the whole of the tegmen tympani is picked away piecemeal. The roof of the internal auditory meatus should also be carefully removed with mallet and chisel. The mastoidal antrum, the tympanum with its contents, the osseous portion of the Eustachian tube, the tensor tympani muscle, and the auditory and facial nerves are now displayed.

The Mastoidal Antrum is a large recess or air-chamber placed behind the tympanum, and communicating by a relatively large opening with that cavity. It is lined with mucous membrane, which is continuous with the lining membrane of the tympanum. The mastoid process is also occupied by the mastoid cells. The greater number of these communicate with the mastoidal antrum, are lined with mucous membrane, and contain air. Still it is well to bear in mind that, as a general rule, a certain proportion of the cells situated in the lower and back part of the process are filled with marrow. The term *pneumatic mastoid process* is applied when all the cells contain air; and the term *diploëtic mastoid process* when the cells contain marrow.

The Tympanic Cavity or Middle Ear is a small chamber filled with air, which is placed between the bottom of the meatus externus and the internal ear or labyrinth. Behind it communicates by a relatively large orifice with the mas-

toidal antrum and air-cells, whilst in front the Eustachian tube opens into it and brings it into connection with the cavity of the pharynx. It contains the chain of auditory ossicles which cross from its outer to its inner wall, and it is lined by delicate mucous membrane.

The vertical depth and the antero-posterior length of the tympanic cavity is about half-an-inch in each case. Its width, however, from side to side, is not more than a sixth-of-an-inch, and as both its outer and inner walls bulge into the cavity, its width in the centre is thereby still further reduced. It presents for examination a roof and a floor with four walls, viz., anterior, posterior, external, and internal.

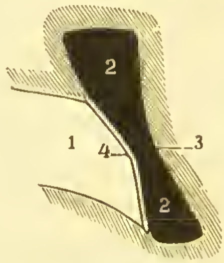


FIG. 318.—Schematic vertical section through the tympanum. (From TESTUT.)

1. External meatus.
2. Tympanic cavity.
3. Promontory or inner wall.
4. Membrana tympani.

The *roof* is composed of a very thin plate of bone termed the tegmen tympani. This separates it from the cranial cavity. In chronic inflammatory conditions of the middle ear an extension of the inflammatory process to the meninges of the brain is always to be apprehended.

The *floor* is also formed by a thin osseous lamina, which is interposed between the tympanum and the jugular fossa, which lodges the internal jugular vein. An extension of an inflammatory condition of the middle ear in this direction, therefore, might lead to thrombosis.

The *posterior wall* presents, in its upper part, the opening into the mastoidal antrum, and below this, close to the inner wall, a small hollow conical projection termed *the pyramid.* This is perforated on its summit, and the aperture leads into a canal which curves backwards and then downwards until it finally opens into the lower part of the last stage of the Fallopian aqueduct. This curved canal lodges the stapedius

muscle, the delicate tendon of which enters the tympanic cavity through the aperture on the summit of the pyramid. On the outer side of the pyramid is the aperture on the posterior wall through which the chorda tympani nerve enters the tympanum.

The *anterior wall* is narrow, because the inner and outer walls become somewhat approximated to each other as they are traced forwards. In its upper part it is deficient, as here the tympanic cavity is directly continued into the osseous part of the Eustachian tube. Above this is the canal, in which is lodged the tensor tympani muscle. In its lower part, below the orifice of the Eustachian tube, the anterior wall is formed by an exceedingly thin plate of bone which intervenes between the tympanic cavity and the ascending part of the carotid canal. This anatomical relation explains the throbbings in the ear, synchronous with the pulsations of the heart, from which certain patients suffer.

The *inner wall* which intervenes between the tympanum and the labyrinth presents certain very important points for study. The greater part of this wall bulges outwards into the cavity in the form of a very evident elevation termed the *promontory.* Above the hinder part of the promontory there is an oval foramen, the long axis of which is directed from before backwards. This is the *fenestra ovalis*, an opening into the vestibular part of the labyrinth, which is closed in the recent state by the foot-piece of the stapes, the innermost of the auditory ossicles. The pyramid on the posterior wall will be seen to lie immediately behind the fenestra ovalis. Above the fenestra ovalis, in the angle formed by the meeting of the roof and inner wall of the tympanum, a ridge, arching from before backwards, will be seen. This is produced by the aqueduct of Fallopius bulging into the tympanum. Its wall is very thin, and allows the white colour of the facial nerve which is contained within the canal to be readily seen. In front of this ridge, in the upper part of the inner wall of the tympanum is the

processus cochleariformis supporting the *tensor tympani muscle.* The processus cochleariformis forms a trough or gutter of bone which runs backwards towards the anterior end of the *fenestra ovalis,* immediately above which it terminates. Here it makes a sharp bend, which

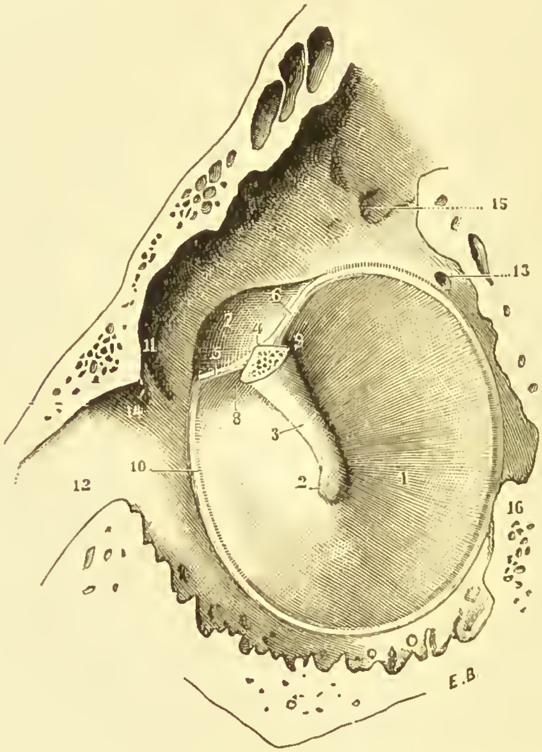


FIG. 319.—The tympanic membrane viewed from the inside. The head of the malleus has been removed. (From TESTUT.)

1. Membrana tympani.
2. Umbo.
3. Handle of the malleus.
4. Processus brevis of the malleus.
5. Plica anterior.
6. Plica posterior.
7. Membrane of Schrapnell.

8 and 9. Two slight fossæ (termed the *fossæ* of Troeltsch).

10. Rim of bone which gives attachment to the membrana tympani.
11. Fissure of Glaser.
12. Eustachian tube.
13. Orifice of entrance for the chorda tympani nerve.
14. Orifice of exit of the same nerve.
15. Point of attachment on the posterior wall of tympanum for the short process of the incus.

almost surrounds the tendon of the tensor tympani, and forms a pulley upon which the tendon plays. Below the hinder end of the promontory is the *fenestra rotunda*, an aperture which, in the macerated bone, leads into the cavity of the cochlea, but which in the recent state, is closed by a membrane which is stretched across it, and receives the name of the *secondary membrane of the tympanum*.

The *outer wall* of the tympanic cavity is formed for the most part by the membrana tympani.

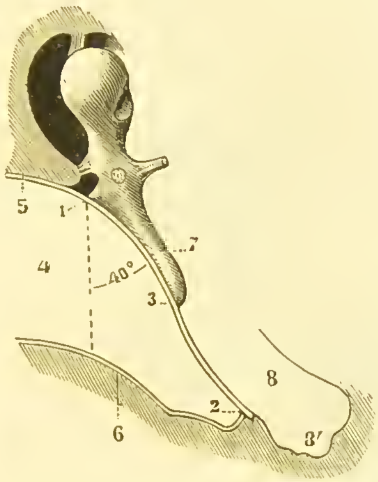


FIG. 320.—Schematic representation of the membrana tympani and the malleus. (From TESTUT.)

1. Processus brevis of malleus.
2. Attachment of membrana tympani.
3. Umbo.
4. External meatus.
5. Its superior wall.
6. Its inferior wall.
7. Handle of the malleus.
8. Tympanic cavity.

Membrana Tympani.—The membrana tympani is an elliptical disc of membrane which is stretched across the bottom of the meatus auditorius externus, so as to form the greater part of the outer wall of the tympanum. It is placed very obliquely; its lower and its fore border both incline inwards. With a horizontal plane it forms an angle which varies from about 40° to 45°.

Its mode of attachment around the bottom of the meatus is deserving of some attention. Here, there is a ring-like ridge of bone very distinctly grooved which forms as it were a frame in which the membrane is set. But this ridge is deficient above, and at this point there is a deep notch (the notch of Rivinus) between the extremities of the bony ridge. This notch is occupied by a portion of the membrane which is not so dense in its texture (see-

ing that the fibrous layer is absent), and not so tightly stretched; consequently it receives the name of the *membrana flaccida* (Schrapnell's membrane).

The membrana tympani is composed of three layers—viz., an outside cuticular layer, an intermediate fibrous lamina, and an inside mucous layer. The handle of the malleus is intimately connected with the fibrous layer, and is covered over by the mucous layer. It draws the membrane inwards towards the tympanic cavity so that the outer surface is deeply concave. The deepest point of this concavity corresponds with the flattened extremity of the handle of the malleus, and is termed the *umbo* or *umbilicus*.

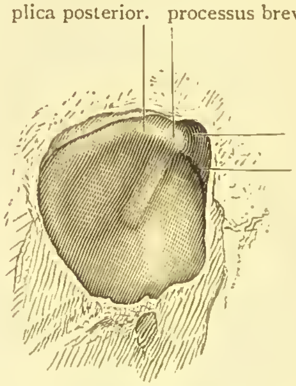


FIG. 321.—The right membrana tympani as seen from the outside. (From MERKEL.) The plica anterior and the plica posterior are the folds which limit the membrana flaccida in front and behind. The handle of the malleus is seen shining through the membrane.

In examining the living ear with a speculum, the surface of the membrane appears highly polished, and a cone of light extends downwards and forwards from the tip of the handle of the malleus. A pair of striæ (Prussak's striæ) called the anterior and posterior folds, extend from the processus brevis to the margins of the notch of Rivinus, and thus map out Schrapnell's membrane. The long process of the incus can be faintly seen through the membrana tympani, parallel to and behind the handle of the malleus.

Tympanic Mucous Membrane.—The tympanum is lined throughout with mucous membrane which is continuous

with the mucous membrane of the pharynx. As already mentioned, it forms the innermost layer of the membrana tympani, and is prolonged backwards into the mastoidal antrum and air-cells. It also covers the ossicles and invests the tendons of the stapedius and tensor tympani muscles.

Auditory Ossicles.—These are termed the malleus, the incus, and the stapes.

The *malleus* presents a head, a neck, a manubrium or handle, and two processes termed respectively, the processus brevis, and the processus gracilis. The *head* is large and rounded. It is directed upwards, and lies above the level of the membrana tympani, close to the roof of the tympanum. On its posterior aspect there is a notch-like articular surface directed backwards for articulation with the body of the incus. The *manubrium* is embedded in the fibrous layer of the membrana tympani. The *processus brevis* is a stunted projection which springs from the root of the manubrium. It is directed outwards, and abuts against the membrana tympani immediately below the membrana flaccida. The *processus gracilis* is a slender spicule of bone which is directed forwards, and enters the Glaserian fissure. It almost invariably breaks in detaching the malleus from the adult skull, but it can be easily preserved in the skull of an infant.

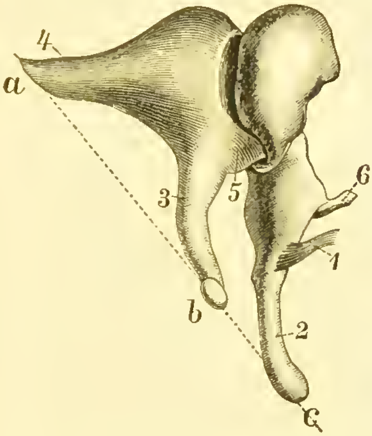


FIG. 322.—Left malleus and incus. (After HELMHOLTZ.)

1. Tendon of tensor tympani.
3. Long process of the incus.
4. Short process of the incus.
6. Processus gracilis of the malleus. The straight line *a.b.c.* connects the extremities of the two processes of the incus with the extremity of the manubrium of the malleus.

The *incus* is shaped somewhat like a bicuspid tooth in

which the fangs are very divergent. It presents a body with a long and a short process. The *body* is provided with an articular surface which looks forwards and articulates with the head of the malleus. The *short process* is directed backwards, and its extremity is attached by ligaments to the posterior wall of the tympanum near the opening into the mastoidal antrum. The *long process* proceeds downwards and inwards in a direction nearly parallel to that of the manubrium of the malleus, but internal, and on a plane posterior to that process. From the inner side of its inferior extremity a small knob of bone (os orbiculare) projects. This articulates with the head of the stapes.

The malleus and incus move together on an axis which is formed by the processus gracilis of the malleus and the short process of the incus. The articular surfaces of the two bones are provided with peculiar catch-teeth which interlock when the bones are performing their ordinary movements. When, however, force is applied to the inner surface of the membrana tympani, as, for instance, when the tympanum is inflated through the Eustachian tube, the malleo-incudal joint gapes and the malleus moves by itself. Traction upon the attachments of the stapes, through the incus, is thus obviated.

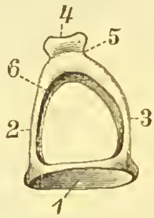


Fig. 323.—The right stapes. (SCHWALBE.)

1. The foot-piece.
2. Anterior crus.
3. Posterior crus.
4. Head or capitulum.
5. Neck.
6. Sulcus stapedis.

The *stapes* is shaped like a stirrup and presents a head or outer extremity separated by a slightly constricted neck from two limbs or crura which join an internal plate or foot-piece. The *head* is excavated by an articular cup for the os orbiculare of the incus. The *crura* are grooved longitudinally on their concave sides (sulcus stapedis). The posterior crus is more sharply curved than the anterior crus. The *foot-piece* fits into the fenestra ovalis and corresponds in its outline with this aperture. Its lower border is straight whilst its upper border is curved.

Ligaments of the Auditory Ossicles.—In addition to the delicate capsular ligaments which surround the joints between the auditory ossicles, there are certain bands which connect the bones to the walls of the tympanum and serve to restrain their movements.

In connection with the malleus there are (1) an *anterior ligament* which passes from its fore part at the root of the processus gracilis to the anterior wall of the tympanum in the neighbourhood of the Glaserian fissure; (2) an *external ligament* which extends from its short process to the margin of the notch of Rivinus; and (3) a *superior ligament* which connects the head with the roof of the tympanum.

The *ligament of the incus* binds the extremity of its short process to the posterior wall of the tympanum, whilst the *annular ligament of the stapes* connects the margin of its foot-piece to the circumference of the foramen ovale.

Tympanic Muscles.—These are two in number, viz., the stapedius inserted into the neck of the stapes, and the tensor tympani inserted into the malleus.

The *stapedius* occupies the interior of the pyramid and the canal which curves downwards from it. The delicate tendon of the stapedius enters the tympanum through the aperture on the summit of the pyramid, and is inserted into the posterior aspect of the neck of the stapes.

The *tensor tympani* arises from the upper part of the cartilage of the Eustachian tube and from the contiguous part of the great wing of the sphenoid. From this it passes backwards and outwards upon the processus cochleariformis and above the osseous part of the Eustachian tube. In the tympanic cavity the tendon turns sharply round the extremity of the processus cochleariformis and proceeds directly outwards, from the inner towards the outer wall of the tympanum, to its insertion into the upper part of the manubrium of the malleus on its internal aspect.

The Chorda Tympani Nerve which traverses the tympanic cavity in close relation to the upper part of the membrana tympani is described on p. 320.

The Tympanic Plexus has also been previously described on p. 341.

The Eustachian Tube is the passage which brings the tympanic cavity into communication with the pharynx and through which air reaches the tympanic cavity and the mastoidal cells. It consists of an osseous and a cartilaginous portion. The *osseous portion* is about half-an-inch in length. It is widest at its entrance into the tympanum, and narrowest

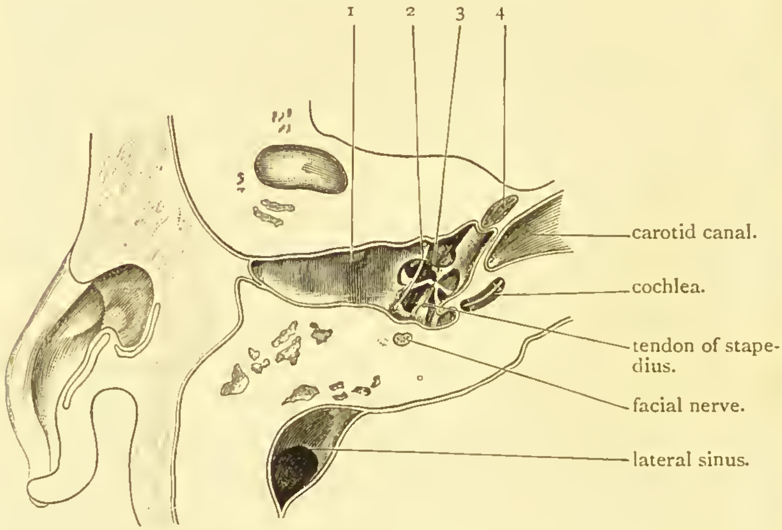


Fig. 324.—Horizontal section through the left organ of hearing (viewed from below).

1. External auditory meatus.
2. Chorda tympani.
3. Tendon of tensor tympani.
4. Tensor tympani.

at its other end. The *cartilaginous portion* is about an inch in length, and has been already described on p. 416.

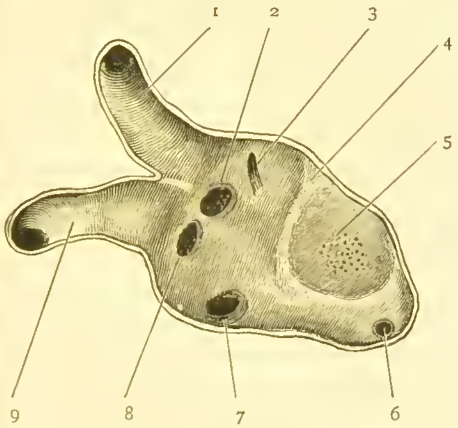
Dissection.—A good deal of the anatomy of the internal ear may be learned by chiselling away the surrounding bone from the harder walls of the different cavities which form the osseous labyrinth. When this is being done the bone must be held in a vice.

Various sections should also be made through the macerated bone. Some of the more essential of these will be described later on.

Internal Ear or Labyrinth.—The labyrinth consists of an intricate system of cavities in the petrous part of the temporal

bone. They contain hollow membranous structures in connection with which the filaments of the auditory nerve end. We therefore recognise an osseous and a membranous labyrinth.

The *osseous labyrinth* is composed of an intermediate chamber termed the vestibule, behind which are placed the three semicircular canals, whilst in front is the cochlea. All these cavities communicate with each other. The corresponding membranous parts do not completely occupy the osseous chambers and the intervening space is filled with a fluid termed the *perilymph.* The *membranous labyrinth* also contains a fluid which receives the name of *endolymph.*



1. Superior semicircular canal.
2. Common opening of superior and posterior semicircular canals.
3. Orifice of aqueduct of the vestibule.
4. Crista vestibuli.
5. Fovea hemispherica.
6. Orifice of scala vestibuli.
7. Orifice of posterior semicircular canal.
8. Orifice of the external semicircular canal.
9. External semicircular canal.

FIG. 325.—The inner wall of the vestibule.

Vestibule.—The vestibule is a small ovoidal bony chamber, the antero-posterior diameter of which is about the sixth-of-an-inch in length. It is situated between the inner wall of the tympanum and the bottom of the internal auditory meatus.

Into the back part of the vestibule the three semicircular canals open by five round apertures; whilst in its lower and fore part is the opening of the scala vestibuli of the cochlea.

On the *outer wall* is the fenestra ovalis, which is closed in the recent state by the delicate periosteal lining of the

chamber and the footpiece of the stapes. When these parts are removed, the vestibule communicates directly through this aperture with the tympanum. On the anterior part of the *inner wall* of the vestibule there is a circular depression, termed the *fovea hemispherica*, which is bounded behind by a vertical ridge, called the *crista vestibuli*. The bottom of the fovea hemispherica is perforated by some minute holes which give admission to filaments from the vestibular part of the auditory nerve. On the *roof* of the vestibule another depression, named the *fovea hemi-elliptica*, may be seen. It is placed behind the crista vestibuli.

A small aperture placed on the posterior part of the inner

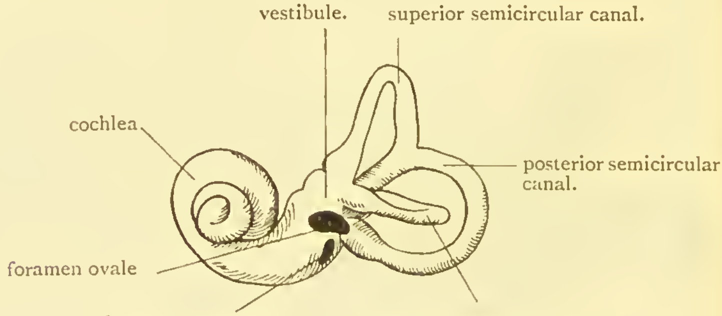


FIG. 326.—From a cast of the left bony labyrinth. (From HENLE.)

wall likewise deserves mention. It is the mouth of the *aqueductus vestibuli*—a small canal which leads backwards to the posterior surface of the petrous bone, where it opens under the dura mater.

Semicircular Canals.—These are three bony canals or tubes placed behind the vestibule. They are bent upon themselves, so that each forms considerably more than half a circle, and they occupy planes at right angles to each other like three faces of a cube. They are termed superior, posterior, and external, and they open into the back part of the vestibule by five round orifices, the number of openings being thus reduced through the adjoining extremities of the

superior and posterior canals becoming fused together so as to present a common orifice. One extremity of each canal where it joins the vestibule becomes expanded into what is termed its *ampulla*. There are thus three ampullated ends.

The *superior semicircular canal* forms the highest part of the labyrinth, and gives rise to a smooth elevation on the anterior surface of the petrous bone, immediately in front of its superior border. It is vertical, and placed somewhat transversely to the long axis of the petrous bone. The *posterior semicircular canal*, which is the longest of the three tubes, is also vertical, and lies in a plane parallel to the posterior surface of the petrous bone. The *external semicircular canal* is the shortest of the tubes, and occupies a horizontal plane.

The Cochlea is a tapering tube which is coiled spirally for two turns and a half around a central pillar, termed the *modiolus*. The appearance produced is somewhat similar to that of a spiral shell. The cochlea lies in front of the vestibule, with its base directed towards the bottom of the internal auditory meatus; whilst its apex looks forwards and outwards, and comes into close relation with the canal for the tensor tympani muscle.

The cochlear tube rapidly diminishes in diameter as it is traced towards the apex of the cochlea, and its closed extremity is termed the *cupola*. The first turn which it takes around the modiolus produces the bulging of the inner wall of the tympanum, which has been described under the name of the promontory.

The *modiolus* is thick at the base, but rapidly tapers towards the apex. Its base abuts against the bottom of the internal auditory meatus. It forms the inner wall of the cochlear tube, and winding spirally round it like the thread of a screw is a thin lamina of bone, which partially subdivides the tube into two compartments. This is termed the *lamina spiralis*.

Numerous minute canals traverse the modiolus, and one more conspicuous than the others, the *central canal of the modiolus*, extends along its centre. The spiral lamina is also tunnelled by small canals in communication with those in the modiolus, whilst one, the *spiral canal of the modiolus*, winds spirally around the central pillar in the attached margin of the spiral lamina. All these channels convey filaments from the cochlear division of the auditory nerve to the membranous cochlea.

The *membranous cochlear tube* is placed between the free margin of the spiral lamina and the opposite side of the wall of the cochlear tube. The two compartments of the bony cochlea are thus separated from each other, and they are respectively termed the scala tympani and the scala vestibuli. The *scala tympani* is the larger of the two. It begins at the foramen rotundum, where the secondary membrane of the tympanum shuts it off from the tympanic cavity. At the apex of the cochlea it communicates by means of an aperture, termed the *helicotrema*, with the scala vestibuli. At the base of the cochlea the *scala vestibuli* communicates with the lower and fore part of the vestibule. The perilymph therefore, in the semicircular canals and vestibule, is directly continuous with that in the scala vestibuli and scala tympani.

It can now be easily understood how vibrations of the membrana tympani are communicated to the perilymph within the osseous labyrinth. The chain of auditory ossicles through the footpiece of the stapes affects the perilymph in the vestibule. The vibrations of the perilymph passing along the scala vestibuli into the scala tympani in turn affect the secondary membrane of the tympanum which is stretched across the foramen rotundum. With every inward movement of the membrana tympani and of the footpiece of the stapes, there is an outward movement of the membrane of the foramen rotundum and *vice versa*. The vibrations of the perilymph affect the endolymph, and thus excite the terminations of the auditory nerve.

Membranous Labyrinth.—In the vestibule there are two membranous sacs termed the utricle and the saccule. The *utricle* occupies the fovea hemi-elliptica on the wall of the vestibule, and lies above and behind the saccule. Into it open the membranous semicircular canals.

The *saccule* is slightly smaller, and occupies the fovea hemispherica on the fore part of the inner wall of the vestibule. It communicates by

means of a short narrow tube, termed the *canalis reuniens*, with the ductus cochlearis or membranous cochlear tube.

The saccule and the utricle are only indirectly brought into communication with each other.

A slender tube termed the *ductus endolymphaticus* occupies the aqueductus vestibuli, and divides into two branches which pass respectively into the saccule and the utricle (Fig. 327).

The *ductus cochlearis*, or *scala media*, as we have already noted, lies between the two scalæ of the cochlear tube. It ends blindly at each extremity, but close to its basal end it is brought into communication with the saccule by the canalis reuniens.

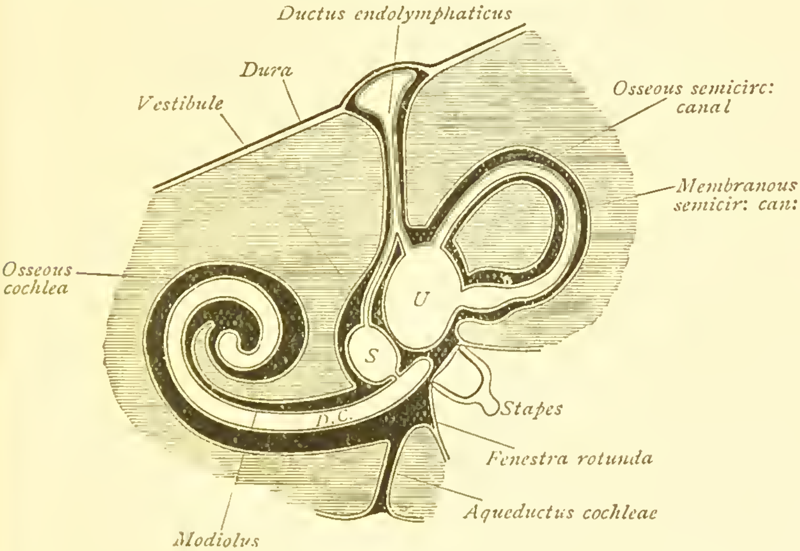


FIG. 327.—Diagram of the osseous and membranous labyrinth (modified from TESTUT.)

U. Utricle. *S.* Saccule. *D.C.* Ductus cochlearis.

Sections through the Temporal Bone. — Having now learned something of the parts which form the auditory apparatus, the student is recommended to extend his knowledge as opportunity arises, by making the following three sections through the macerated bone.

(1) A coronal section passing through the internal and external auditory meatuses, nearer to their anterior than to their posterior walls (Fig. 328). (2) A vertical section nearly parallel to the superior border

of the petrous bone, passing through the hiatus Fallopii, and the highest part of the eminence which is produced by the superior semicircular canal (Fig. 329). (3) A section parallel to the superior border of the petrous portion of the temporal bone, and about an eighth of an inch external to that border (Fig. 330).

Section I.—The points which are exhibited by the first of these sections are depicted in Figure 328. At the inner extremity of the external auditory meatus is the grooved ridge for the membrana

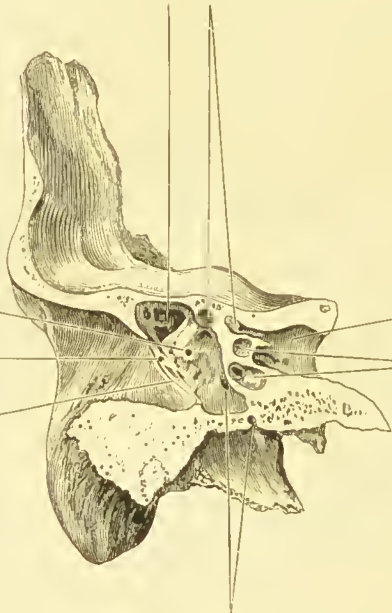


FIG. 328.—Coronal section of the right temporal bone passing through the internal and external auditory meatuses.

tympani. Passing through the floor of the tympanum is the canal for Jacobson's nerve; its internal opening is just below the promontory. The promontory is seen in section. The posterior wall shows the iter chordæ posterius, the pyramid, and the opening into the mastoid antrum. The mastoid antrum is roofed over by a thin plate of bone termed the tegmen tympani. The acute bend in the aqueduct of Fallopius, which corresponds to the geniculate ganglion of the facial nerve, has been cut across, showing the canal divided in two places.

On the cut surface of the opposite part of the bone (not figured) several turns of the cochlea will be found to be cut across, and the communication of the bend of the aqueduct of Fallopius with the hiatus Fallopii will be seen. On the same piece of bone the student should also note the canal for the tensor tympani, which is situated immediately above the processus cochleariformis, and the Eustachian tube which lies below that thin bony lamella. He should pass a pin through the Glaserian

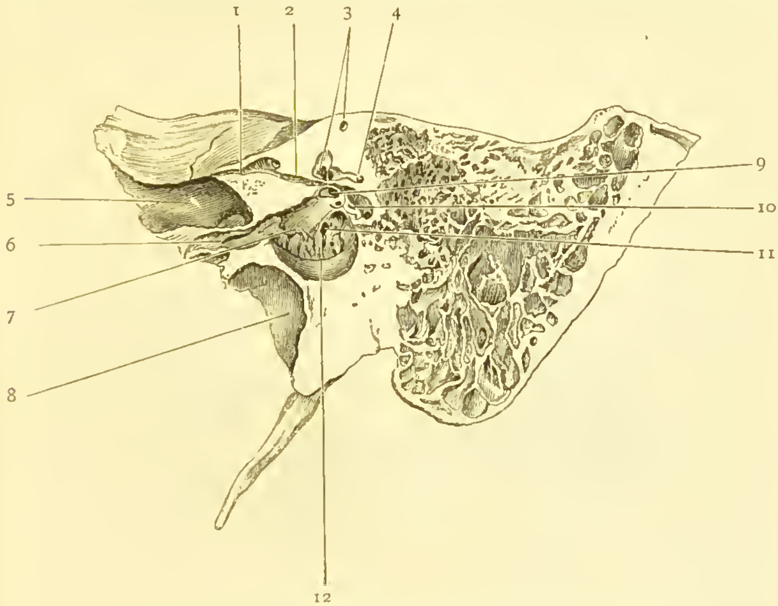


Fig. 329.—Vertical section of the left temporal bone passing through the hiatus Fallopii, and nearly parallel to the superior border of the petrous bone.

1. Hiatus Fallopii.
2. Aqueduct of Fallopius.
3. Superior semicircular canal.
4. External semicircular canal.
5. Carotid canal.
6. Eustachian tube.
7. Promontory.
8. Jugular fossa.
9. Fenestra ovalis.
10. Pyramid.
11. Fenestra rotunda.
12. Ridge for membrana tympani.

fissure, and in this way ascertain its internal opening. Immediately external to that opening he will find the continuation of the ridge for the membrana tympani.

Section II.—The parts in this section are exhibited in Fig. 329. The superior and external semicircular canals are divided, and their ampullæ are shown. The middle portion of the aqueduct of Fallopius is laid open, and the two bends of that canal are seen. Just in front of

the posterior bend is the opening of the pyramid. The pyramid is connected to the promontory by a little spicule of bone, which has been compared to a flying buttress (Holden). The promontory forms a bold eminence on the inner wall of the tympanum. Above it is placed the fenestra ovalis, below and behind it is the fenestra rotunda. The latter opening is somewhat under the shadow of the promontory.

Section III.—In the section from which Fig. 330 is taken, the saw has passed through the cochlea and the vestibule, the superior and ex-

FIG. 330.—Vertical section of the left temporal bone parallel to the superior border of the petrous bone, and about one-eighth of an inch anterior to that border.

1. Opening of superior and posterior semicircular canals into vestibule.
2. Superior semicircular canal.
3. Fovea hemi-elliptica.
4. Aqueduct of Fallopius.
5. Cochlea.
6. Carotid canal.
7. External semicircular canal.
8. Aqueductus vestibuli.
9. Posterior semicircular canal.
10. Aqueduct of Fallopius.
11. Fovea hemispherica.

ternal semicircular canals, and the first and third parts of the aqueduct of Fallopius. The modiolus or axis of the cochlea is cut transversely near its base. If the specimen be held up to the light and examined with a pocket-lens, the modiolus will be seen to be pierced by a number of fine holes (lamina cribrosa). At the end of the lowest turn of the cochlea, close to the fenestra rotunda, is the inner opening of the

aqueductus cochleæ, a canal which transmits a small vein to the commencement of the internal jugular vein. Within the cavity of the vestibule the following objects may be seen :—the fovea hemispherica for the saccule, the fovea hemi-elliptica for the utricle, the common opening of the posterior and superior semicircular canals, the ampulla of the posterior semicircular canal, and the internal opening of the aqueductus vestibuli. The latter canal transmits minute veins to the inferior petrosal sinus, and lodges a process of the membranous labyrinth (ductus endolymphaticus).

THE EYEBALL.

The eyeball is not perfectly spherical; it may be said to be composed of the segments of two spheres. The anterior or corneal segment, forming only about one-sixth of the entire eyeball, possesses a shorter radius than the hinder or sclerotic segment. The anterior clear corneal part of the eyeball forms, therefore, a dome-like bulging or prominence on the front of the globe of the eye. The terms *anterior* and *posterior pole* are respectively applied to the central points of the anterior and posterior curvatures of the eyeball. The imaginary line which joins these poles receives the name of the *sagittal axis*, whilst another line drawn in a coronal direction around the globe of the eye midway between the two poles so as to divide the eyeball into two hemispheres is termed the *equator*. Imaginary *meridional lines* are also drawn between the two poles so as to cut the equatorial line at right angles. In studying the structure of the eyeball it is necessary to have a proper understanding of these terms.

Dissection of the Eyeball.—A satisfactory dissection of the globe of the eye can only be made when the eyeball is fresh; and in the dissecting-room it is impossible to obtain suitable specimens. This does not in reality matter very much because it is always easy to procure eyeballs of the pig, sheep, or ox, which suit the purpose admirably. It is

essential, however, that the dissector should always complete his study of the organ by the examination of a fresh human eyeball obtained from the *post mortem* room. In point of size and also in other particulars the eyeball of the pig more closely resembles the human eyeball, but it is perhaps better that the student should begin with the eyeball of the ox, seeing that the dissection can be more easily carried out.

We shall suppose then that the dissector has provided himself with six eyeballs obtained from oxen. His first duty is to remove from these the conjunctiva, capsule of Tenon, ocular muscles, and fat, which adhere to them. Pinching up with the forceps the conjunctiva and capsule of Tenon close to the corneal margin, he should snip through

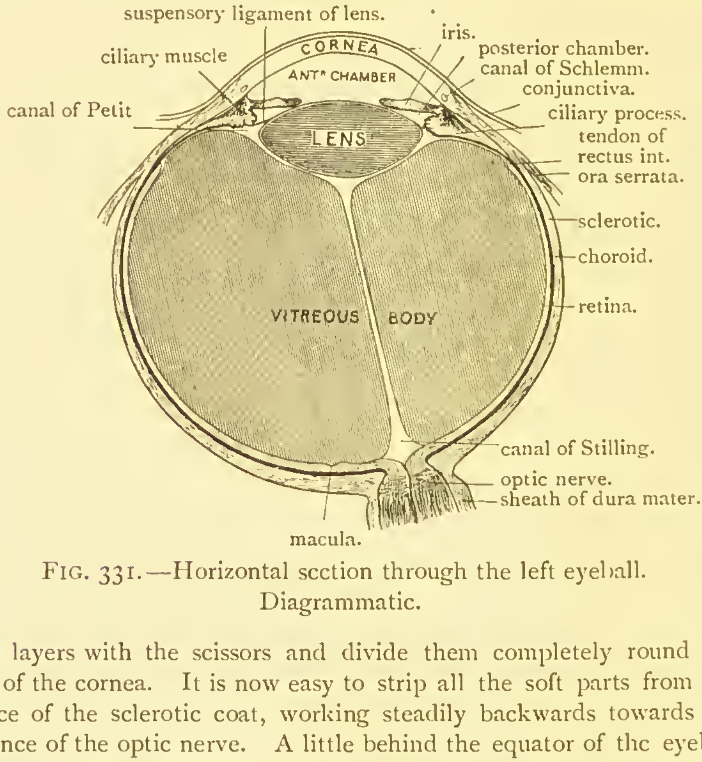


FIG. 331.—Horizontal section through the left eyeball. Diagrammatic.

these layers with the scissors and divide them completely round the edge of the cornea. It is now easy to strip all the soft parts from the surface of the sclerotic coat, working steadily backwards towards the entrance of the optic nerve. A little behind the equator of the eyeball the venæ vorticosæ will be noticed issuing at wide intervals from the sclerotic coat, and on approaching the posterior aspect of the eyeball the posterior ciliary arteries and the ciliary nerves will be seen piercing the same coat around the entrance of the optic nerve.

Before beginning the actual dissection of the eyeball, it is important that the student should obtain a general conception of the parts which compose it. This can best be done by selecting two of the specimens

and making sections through them in two different planes. One specimen may be divided at the equator into an anterior and a posterior portion, whilst the other may be divided in an antero-posterior direction into a mesial and a lateral half. These sections cannot be made with the knife. The eyeballs must first be frozen perfectly solid, and then the division can be made by a fine saw. The freezing of the specimens is a very simple matter. They should be placed in a small tin box, and the box surrounded by a mixture of ice and salt. Two, or at most three, hours is sufficient to complete the process. When the sections are made, they should be placed under water in a cork-lined tray, and preserved for reference as the study of the eyeball is proceeded with.

General Structure of the Eyeball.—The eyeball consists of three concentrically arranged coats enclosing a cavity in which are placed three refracting media.

The tunics are: (1) an external fibrous envelope composed of a posterior opaque part, called the *sclerotic coat*, and an anterior clear transparent portion called the *cornea*; (2) an intermediate vascular envelope, in which we recognize three subdivisions, viz., a hinder part called the *choroid coat*, a front portion termed the *iris*, which lies behind the cornea, and an intermediate *ciliary zone*; (3) the nervous inner tunic or *retina* in which the fibres of the optic nerve spread out.

The refracting media are: (1) behind the cornea a watery fluid, called the *aqueous humour*, contained in a space partially subdivided by the iris into the *two chambers of the eye*; (2) the *crystalline lens* behind this; and (3) the *vitreous body*, occupying the posterior part of the interior of the eyeball.

Dissection.—The superficial surface of the sclerotic coat and the cornea should now be examined, but to complete the study of the external tunic, a further dissection is required. Selecting an eyeball for this purpose, an incision should be made with a sharp knife through the sclerotic at the equator. This must be done carefully, and the moment that the subjacent black choroid coat appears the knife should be laid aside. The cut edge of the sclerotic should now be seized with the forceps, and the incision carried completely round the eyeball with the scissors along the line of the equator. The outer fibrous tunic is thus divided into an anterior and a posterior portion. These must now be raised from the subjacent parts. As the anterior portion is turned for-

wards, some resistance will be met close to the margin of the cornea from the attachment of the ciliary muscle to the deep surface of the sclerotic. This can easily be broken through with the blunt point of the closed forceps; as soon as this is done the aqueous humour escapes. In the case of the posterior part of the sclerotic, its complete separation can be effected by dividing the fibres of the optic nerve close to the point where they appear through the sclerotic.

When the above dissection is successfully carried out, the outer fibrous tunic is isolated in two portions, whilst a continuous view of the intermediate vascular coat is obtained. The eyeball, denuded of its external tunic, should now be placed in a shallow vessel filled with water.

Sclerotic Coat.—The sclerotic is what is commonly known as the white of the eye. It is a dense, resistant

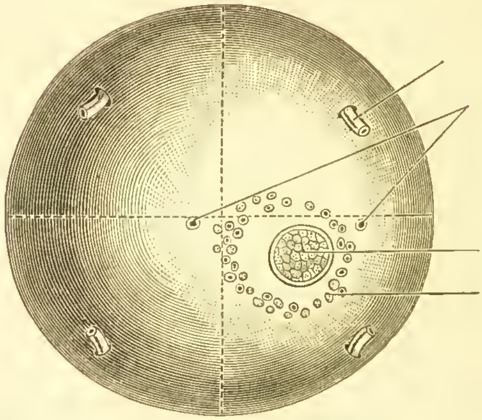


FIG. 332.—Posterior aspect of left eyeball. (After TESTUT, modified.)

tunic, opaque-white in colour, which envelopes the posterior five-sixths of the globe of the eye. It is thickest behind, and becomes thinner as it is traced forwards. Near the cornea, however, it again becomes thicker owing to the accession of fibres which it receives from the tendons of the ocular muscles. Except at the optic entrance and close to the margin of the cornea, where it adheres to the surface of the subjacent ciliary muscle, the deep surface of the sclerotic is very loosely attached to the choroid coat. Some pigmented flocculent connective tissue, termed the

lamina fusca, passes between the two coats and traverses what is in reality an extensive lymph space.

The point at which the optic nerve pierces the back part of the sclerotic does not correspond with the posterior pole of the eyeball. The *optic entrance*, as it is termed, is situated about 3 m.m. to the inner or nasal side of the posterior pole and very slightly below it. Here the outer fibrous sheath of the optic nerve, which is derived from the dura mater, blends with the sclerotic coat, whilst the bundles of nerve-fibres are carried forwards through a series of small apertures. This perforated portion of the sclerotic is called the *lamina cribrosa.*

The sclerotic coat is also pierced by numerous blood vessels and nerves. Thus the long and short posterior ciliary arteries with the ciliary nerves perforate the sclerotic around the optic entrance ; four or five venæ vorticosæ issue from the interior of the eyeball by piercing the sclerotic a little way behind the equator at wide intervals from each other ; whilst the anterior ciliary arteries pierce the same coat near the corneal margin.

In front the sclerotic coat is not only contiguous with, but is directly and structurally continuous with, the cornea. This is termed the *corneo scleral junction*, and the faint groove on the surface which corresponds with it receives the name of the *scleral sulcus.* At this junction the sclerotic tissue slightly overlaps the corneal tissue so that the line of union when seen in section is oblique. Close to this a minute canal, termed the *canal of Schlemm*, encircles the margin of the cornea.

The Cornea forms the anterior sixth of the outer fibrous tunic of the globe of the eye. It is transparent and glass-like, and it forms the window through which the rays of light gain admittance into the eyeball. The curvature of the cornea is more accentuated than that of the sclerotic, and thus it constitutes the segment of a smaller sphere. When viewed from behind it appears circular, but when looked at from the front it is seen to be slightly wider in the

transverse direction. This is due to the fact that the sclerotic overlaps it to a greater extent above and below than it does at the sides. This is particularly noticeable in the eyeball of the ox. The posterior concave surface of the cornea forms the front boundary of the anterior chamber of the eyeball, and is separated by the aqueous humour from the anterior surface of the iris.

The anterior convex surface of the cornea is clothed by the conjunctiva which is here reduced to its epithelial layer. Behind there is an elastic glassy stratum, termed the *elastic membrane of Descemet.* When the cornea is relaxed this membrane becomes wrinkled, and it can be torn away in shreds from the proper corneal tissue. When dealt with in this way the portions removed show a tendency to curl up.

Ligamentum Pectinatum Iridis.—At the margin of the cornea the membrane of Descemet becomes fibrillar, and some of its fibres are continued into the iris forming the *pillars of the iris* or the *ligamentum pectinatum iridis*, whilst others are prolonged backwards into the choroid and the sclerotic. The ligamentum pectinatum iridis bridges across the angle between the cornea and the iris, and the bundles of fibres into which the membrane of Descemet breaks up in this region constitute an annular meshwork or sponge-like series of minute spaces termed the *spaces of Fontana.* These communicate with the anterior chamber of the eyeball, and are filled with lymph or aqueous humour.

Intermediate Vascular Tunic.—The intermediate or vascular tunic is exposed in its entire extent in the eyeball, from which the sclerotic coat and the cornea have been removed. As previously mentioned, the vascular tunic consists of three portions, viz., a choroid coat, a ciliary zone, and the iris. The *choroid coat* is the dark-coloured portion which lies behind the ciliary muscle. The *ciliary zone* consists of a superficial *ciliary muscle* and the subjacent *ciliary processes.* The ciliary muscle presents the appearance of a

conspicuous white, ring-like band, which encircles the fore part of the eyeball immediately behind the corneo scleral junction. The ciliary processes are directly continuous behind, under the ciliary muscle, with the choroid coat, and also in front with the iris. The *iris* is a circular curtain with a central aperture which lies behind the cornea.

The Choroid Coat is pierced behind by the optic nerve, and is somewhat thicker behind than it is in front. Its superficial surface is connected with the deep surface of the sclerotic by some lax connective tissue (lamina fusca) and also by blood vessels and nerves which pass from the one into the other. The deep surface of the choroid is moulded upon the retina and connected with a layer of deeply-pigmented cells, which usually adheres to the choroid when this tunic is removed, although in reality it must be regarded as a portion of the retina.

In the eyes of many mammals, but not in man, the posterior part of the choroid when viewed from the front presents an extensive brightly coloured area, which exhibits a metallic lustre. This appearance is due to the presence of an additional layer in the choroid termed the *tapetum*. In the horse, elephant, ox, the tapetum is composed of fibres (tapetum fibrosum); in carnivora, it is formed of cells (tapetum cellulosum). In the ox, it is a brilliant green colour with a golden lustre; in the dog, it is white with a bluish border; in the horse, it is blue with a silvery lustre.

The chief bulk of the choroid coat is composed of blood vessels. These are arranged in two well-marked layers, viz., a deep, closely-meshed capillary layer called the *tunica chorio-capillaris* or the *tunica Ruyschiana*, and a more superficial venous layer composed of the *vasa vorticosa*. The short posterior ciliary arteries proceed forwards between these vascular layers.

The eyeball in which the outer surface of the choroid is exposed should be immersed in water and the pigment washed out of it by means of a camel-hair brush. The vasa vorticosa will then appear as white curved lines converging towards four or five points, from which the larger venæ vorticosæ take origin (Fig. 333).

Ciliary Muscle.—This is composed of involuntary muscular tissue, but the arrangement of its fibres can only be seen when thin sections of the eyeball are examined under the microscope. The fibres are then seen to be disposed in two groups, viz., a radiating and a circular.

The *radiating fibres* arise from the deep aspect of the sclerotic coat close to the margin of the cornea. From this they radiate backwards in a meridional direction, and gain

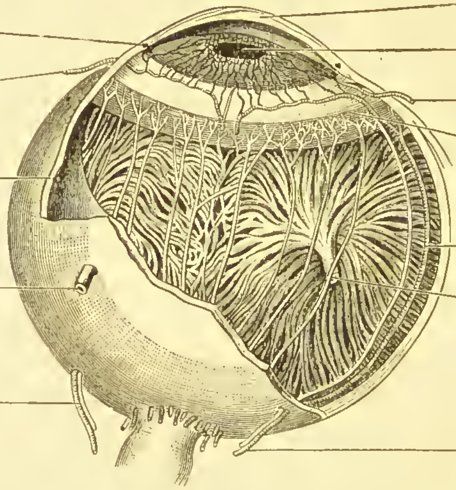


FIG. 333.—Dissection of the eyeball showing the vascular tunic and the distribution of the ciliary nerves and vessels.

insertion into the choroid coat in the region of the ciliary processes.

The *circular fibres* consist of two or three bundles placed upon the deep aspect of the radiating portion of the muscle. They form a muscular ring around the circumference of the iris.

Dissection.—To obtain a view of the ciliary processes, a coronal section should be made with the scissors through an eyeball a short distance in front of the equator. The portion of the vitreous body which occupies the anterior segment of the eyeball should be carefully removed. When this is done, the deep aspect of the ciliary processes will be seen as they

radiate backwards from the circumference of the crystalline lens. By washing out the pigment from this part of the vascular tunic, the arrangement of the processes will be more fully displayed.

A second dissection may be made in another eyeball with the object of exposing the ciliary processes from the front. In this case remove the cornea with the scissors by cutting round the corneo scleral junction. The iris is now brought conspicuously into view, and may, with advantage, be studied at this stage. Several cuts in the meridional direction, and at equal intervals from each other, should in the next place be made through the anterior part of the sclerotic coat. The strips of sclerotic should then be separated from the ciliary muscle, and pinned backwards in a cork-lined tray filled with water. The last step in the dissection consists in the removal of the iris.

Ciliary Processes.—When the choroid coat is traced forwards under the ciliary muscle, it is seen to form a series

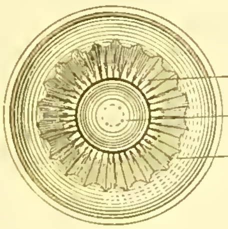


FIG. 334.—The ciliary processes of the human eyeball viewed from behind. (From MERKEL.)

of elongated prominent thickenings, which radiate backwards from the margin of the crystalline lens like the folds of a goffered frill. These thickenings are the ciliary processes. They vary slightly in their degree of prominence, and also in length, but they are very constant in number. In the human eye seventy ciliary processes, as a rule, may be counted. As each process proceeds forwards, it becomes gradually more and more prominent until ultimately it ends in a thickened projection, which occupies the space between the margin of the iris and the circumferential part of the anterior surface of the crystalline lens. In this position the ciliary processes bound peripherally the posterior chamber of the eyeball (Fig. 331).

The ciliary processes rest upon the subjacent zonule of Zinn, *i.e.*, the membrane, which covers the fore part of the vitreous body. This membrane is adapted in the most intimate manner to the ciliary processes. It is folded or wrinkled in such a way that the folds occupy the sulci or valleys between the processes.

The Iris lies in front of the crystalline lens, and it is separated from the cornea by the anterior chamber filled with aqueous humour. By its circumference it is continuous with the choroid coat, and it is at the same time connected by the ligamentum pectinatum iridis with the margin of the cornea.

The iris is circular in form, and is perforated in the centre by a round opening which is termed the *pupil*. Its anterior surface is faintly striated in a radial direction. It is coloured differently in different individuals. Its posterior surface is deeply pigmented. The pupil presents a very nearly circular outline,[1] and during life it constantly varies in its dimensions so as to control the amount of light which is admitted into the interior of the eyeball. These changes in the size of the pupil are produced by the contractile properties of two groups of involuntary muscular fibres which are present in its substance. One group is composed of muscular fibres, arranged circularly around the pupil in the form of a *sphincter;* the second group consists of fibres, which have a radial direction, and pass from the sphincter towards the circumference of the iris, so as to constitute a *dilatator muscle*. By many anatomists these radial fibres are considered to be *elastic* and not *muscular*.

Ciliary Nerves.—The ciliary nerves which arise from the lenticular ganglion and the nasal nerve, after piercing the sclerotic at the back of the eyeball around the optic entrance, extend forwards between this coat and the choroid.

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[1] It may be as well to mention here that the pupil in the ox and the sheep is greatly elongated in the transverse direction. In the pig, however, it is approximately circular.

They will be seen in the specimen in which the sclerotic has been turned backwards in separate flaps in the form of delicate white filaments (Fig. 333). In the posterior part of the eyeball they occupy grooves on the deep surface of the sclerotic, and can only be separated from it with difficulty. Reaching the ciliary zone the ciliary nerves break into branches, which join in a plexiform manner and send twigs to the ciliary muscle, the iris, and the cornea.

Ciliary Arteries.—Of these we recognise three groups, viz. :—(1) the short posterior ciliary arteries; (2) the long posterior ciliary arteries; and (3) the anterior ciliary arteries.

The *short posterior ciliary arteries*, branches of the ophthalmic, pierce the sclerotic around the optic entrance, and are distributed in the choroid coat between the vasa vorticosæ and the membrana chorio-capillaris.

The *long posterior ciliary arteries*, also branches of the ophthalmic, are only two in number. They perforate the sclerotic on either side of the optic nerve (Figs. 332 and 333), a short distance beyond the short ciliary arteries, and are then carried forwards between the sclerotic coat and the choroid. When they gain the ciliary zone each artery divides into an ascending and a descending branch, and these, with the anterior ciliary arteries, form an arterial ring termed the *circulus iridis major*. From this branches are given to the ciliary muscle, the ciliary processes, and the iris.

The *circulus iridis minor* is the name applied to a second arterial ring in the iris at the outer border of the sphincter pupillæ.

The *anterior ciliary arteries* are very small twigs, which arise from the branches of supply to the recti muscles. They pierce the sclerotic close to the margin of the cornea, take part in the formation of the circulus iridis major, and send twigs to the ciliary processes.

Venæ Vorticosæ.—From each venous vortex in the choroid a large vein arises, which makes its exit from the eyeball by piercing the sclerotic obliquely a short distance behind the equator. They are four or five in number.

Dissection.—The vitreous body and retina in the hinder part of the eyeball, which was cut into two for the purpose of exposing the ciliary processes from behind, should now be dislodged. By raising the choroid coat from the deep surface of the sclerotic, under a flow of water from the tap, the venæ vorticosæ entering the deep surface of the sclerotic will be brought into view. When these are divided, and the separation of the two coats is carried back towards the optic entrance, the posterior short ciliary arteries as they emerge from the sclerotic and enter the back part of the choroid will be seen.

In the eyeball from which the sclerotic and cornea have been removed, the iris, ciliary processes, and the choroid, should be carefully stripped off piecemeal under water. This will expose the retina.

The Retina is composed of two strata—viz., a thin *pigmentary layer*, which adheres to the deep surface of the choroid coat, and has been removed with it, and a delicate *nervous layer*, which is moulded on the surface of the vitreous body, but presents no attachment to it except at the optic entrance. The latter extends forwards beyond the equator of the eyeball, and a short distance from the ciliary zone it appears to end in a well-defined wavy or festooned border termed the *ora serrata.* This appearance, however, is somewhat deceptive. The nervous elements, it is true, come to an end along this line, but a lamina in continuity with the retina is in reality prolonged forwards as far as the margin of the pupil. The part in relation to the ciliary processes is exceedingly thin, and cannot be detected by the naked eye. It is termed the *pars ciliaris retinæ.* The portion on the deep surface of the iris forms its posterior *uveal pigmentary layer* (pars iridica retinæ).

During life the *retina proper* is transparent, but after death it soon assumes a dull greyish tint and becomes opaque. Posteriorly it is tied down at the optic entrance. When viewed from the front this appears as a conspicuous circular disc termed the *porus opticus* or *optic disc.* From this spot the optic nerve fibres radiate out so as to form the deep layer of the retina. The optic disc, in correspondence with the entrance of the optic nerve, lies to the inner or nasal side of the antero-posterior axis of the eyeball. Exactly in

the centre of the human retina, and therefore in the axis of the globe of the eye, there is a small yellowish spot termed the *macula lutea*.[1] It is somewhat oval in outline, and in its centre it is depressed, thereby forming what is called the *fovea centralis*.

Retinal Arteries and Veins.—In a fresh eyeball the *arteria retinæ centralis* (Fig. 335) will be seen entering the retina at the optic disc. It immediately divides into an ascending and a descending branch, and each of these breaks up into a large outer or temporal division, and a

FIG. 335.—Diagram of the retina and retinal vessels as seen from the front. The veins are represented black, whilst the arteries are drawn in outline.

smaller inner or nasal division. These ramify in the retina as far as the ora serrata; but the resultant branches do not anastomose with each other nor with any of the other vessels in the eyeball.

The *retinal veins* converge upon the optic disc, and disappear into the substance of the optic nerve in the form of two small trunks which soon unite.

[1] There is no macula lutea in the eyeball of the ox or sheep.

The retinal vessels, the optic disc, and the macula can all be examined in the living eye by means of the ophthalmoscope. The red reflex obtained from the fundus of the eyeball is produced by the blood in the membrana chorio-capillaris.

Dissection.—For the study of the vitreous body and the crystalline lens, which together may be termed the "eye-kernel," it is better to take an eyeball which is not perfectly fresh (Anderson Stuart). The eyeball selected for this purpose should be allowed to stand untouched from one to three days according to the season. The coats of the eye should then be divided round the equator, and on gently separating the cut edges, and turning the coats forwards and backwards, the "eye-kernel" will slip out. It should be allowed to drop into a vessel filled with clean water. The examination of the parts forming the eye-kernel will be greatly facilitated by placing it *en masse* in strong picro-carmine solution for a few minutes. When removed from the staining fluid, it should be well washed in water. In this way the hyaloid membrane enclosing the vitreous body, the capsule of the lens, and the zonule of Zinn, are stained red, and their connections become very apparent (Anderson Stuart).

The Vitreous Body is a soft, yielding, perfectly transparent jelly-like body, which occupies the posterior four-fifths of the interior of the eyeball. The retina is spread over its surface as far forwards as the ora serrata, but is in no way attached to it, except at the optic disc. In front of the ora serrata, the ciliary processes are applied to the vitreous body and indent its surface. Anteriorly, the vitreous body is hollowed out, and presents a deep concavity, the *fossa patellaris*, for the reception of the posterior convex surface of the crystalline lens.

The substance of the vitreous body is enclosed within a delicate transparent membrane, which completely envelops it, and receives the name of the *hyaloid membrane.* Extending forwards through the midst of the vitreous mass from the region of the optic disc to the back of the crystalline lens is a minute canal, lined by a tube-like prolongation of the hyaloid membrane, and containing a watery fluid. This is termed the *hyaloid canal*, or the *canal of Stilling*, and it represents the path which was taken by a branch of the

arteria retinæ centralis, which in the fœtus extends forwards for the supply of the capsule of the lens, but afterwards disappears.

The canal of Stilling, as a rule, cannot be seen in an ordinary dissection of the eyeball; but if the eye-kernel be shaken up in the picro-carmine solution as recommended by Anderson Stuart, it may sometimes be rendered evident through the staining fluid entering it.

Zonula of Zinn and the Suspensory Ligament of the Lens.—In the ciliary region the hyaloid membrane of the vitreous body becomes thickened and strengthened, and

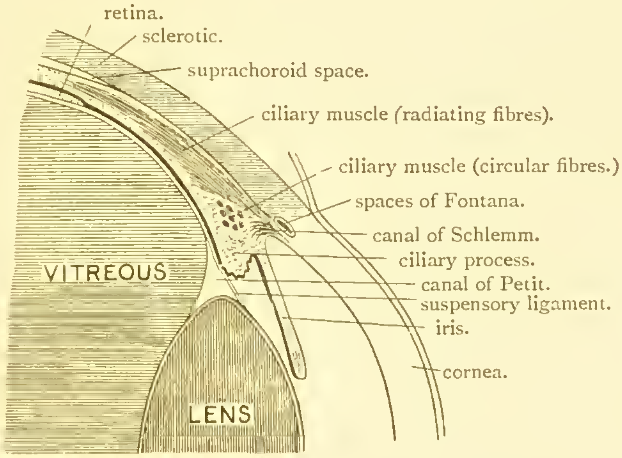

FIG. 336.– Diagrammatic representation of the ciliary region as seen in vertical section.

forms what is termed the zonula of Zinn. As this approaches the margin of the crystalline lens, it splits into two parts, viz., an exceedingly delicate deep lamina, which lines the fossa patellaris (Anderson Stuart), and a more superficial stronger part, which becomes attached to the capsule of the crystalline lens.

The zonula of Zinn lies subjacent to the ciliary processes, and is radially plaited or wrinkled in correspondence with these. Thus the elevations or wrinkles of the zonule extend

into the intervals between the ciliary processes, whilst the ciliary processes in their turn lie in the depressions between the wrinkles of the zonula. When the eye is fresh, these opposing parts are closely adherent.

The zonula of Zinn is strengthened by radially directed meridional elastic fibres, and after the delicate membrane which lines the fossa patellaris is given off from its deep surface, it extends forwards as a distinct layer, and is attached to the anterior surface of the capsule of the lens a short distance beyond the margin of that body. In this manner the *suspensory ligament of the lens* is formed. But this is not the only attachment of the suspensory ligament. Some scattered fibres are attached to the circumference or equator of the lens (equatorial fibres), whilst others are fixed to its posterior surface close to its margin (post-equatorial fibres).

In this way the crystalline lens is firmly held in its place in the fossa patellaris. Further, the degree of tension of its suspensory ligament is influenced by the radiating fibres of the ciliary muscle, which by their contraction pull upon the ciliary processes, and produce relaxation of the zonule of Zinn.

Canal of Petit.—This is a circular lymph space, which surrounds the circumference of the lens. It is bounded in front by the suspensory ligament, and behind by the hyaloid membrane, enclosing the vitreous body. It is filled with a watery fluid.

By introducing the point of a fine blow-pipe into the canal of Petit through the suspensory ligament, it can be partially, or, perhaps, completely, inflated with air. It then presents a sacculated appearance.

Dissection.—The crystalline lens may be removed by snipping through the suspensory ligament with scissors.

Crystalline Lens.—The crystalline lens is a biconvex, solid, and transparent structure, which lies behind the iris, and in front of the vitreous body. It is enclosed within a

glassy, elastic capsule, to which the different parts of the suspensory ligament are firmly cemented, and it presents for study an anterior surface, a posterior surface, and a circumference or equator.

The *anterior surface* is not so highly curved as the posterior surface. Its central part which corresponds with the pupillary aperture of the iris looks forward into the anterior chamber of the eye. Around this part the margin of the pupillary orifice of the iris is in contact with the lens, whilst nearer the equator the anterior surface of the lens is separated from the iris by the fluid in the posterior chamber of the eyeball. The *posterior surface* of the lens presents a higher degree of curvature than the anterior surface, and is received into the fossa patellaris of the vitreous body. The *equator or circumference* is rounded. It forms one of the boundaries of the canal of Petit, and the manner in which the suspensory ligament is attached to the capsule in this vicinity has already been described.

Faint radiating lines may be seen on both surfaces of the lens. These give a clue to the structure of the lens. They indicate the planes along which the extremities of the lens-fibres come into apposition with each other.

The *capsule* of the lens is a resistant glassy membrane, which is considerably thicker in front than behind.

The anterior wall of the capsule may now be divided with a sharp knife. A little pressure will cause the body of the lens to escape through the opening. The stained capsule, whilst floating in water, can be very advantageously studied.

If the lens body be compressed between the finger and thumb, it will be observed that the outer portion or cortical part is soft, whilst the central part or *nucleus* is distinctly firmer. When the lens is hardened in alcohol it can easily be proved that it is composed of numerous concentrically arranged laminæ.

Chambers of the Eyeball.—The *anterior chamber* of the eyeball is the space between the cornea in front, and the iris and central part of the lens behind. At the irido-corneal angle, it is bounded by the ligamentum pectinatum,

and here the aqueous humour which fills this chamber finds access to the spaces of Fontana.

The *posterior chamber* is a circular space or interval which is bounded in front by the posterior surface of the iris, and behind by the circumferential part of the anterior face of the lens. Externally, this space is closed by the thick anterior projecting ends of the ciliary processes. It is also filled with aqueous humour.

INDEX.

INDEX.[1]

[1] The Author is indebted to Dr. C. R. Browne, Assistant in the Anthropological Laboratory of Trinity College, for the drawing up of this Index.

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